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CONTENTS:

Negative Phototaxis and other Properties of Littorina as Factors in Determining its Habitat.

BY

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During my stay at the Marine Biological Station, Misaki in the summer of 1900, I spent a part of my time in making some experiments on *Littorina*, and the results embodied in the following pages are published with the hope that they may prove of some interest to those who are engaged in similar studies. I wish to express my thanks to Mr. N. Yatsu and Mr. T. Tsuchida for various assistance rendered during the progress of the experiments.

The species of *Littorina* that is commonest about the Station is *L. exigua* DUNKER. There is a second species also very abundant, *L. sitchana* PHIL. of which the var. *brevicula* is very conspicuous. Both species live from the highest tide-level down for distances equal to a vertical height of about two to three feet. They cease to be found long before the lowest tide-mark is reached which is perhaps four or five feet still further down. The experiments recorded were made mostly on *L. exigua*, as this is an easily diagnosed species and as it was desirable that the experiments should be performed on one and the same species. I shall not attempt to describe all the experiments performed but only such as are important in bringing out the salient points.

After the fact that *Littorina* shows a strong negative phototaxis was established, I performed the following experiments :—

Experiment 2 *—The following arrangements were fixed up. A

* The number is that used in my note-book.

glass-plate A (Fig. 1) which happened to be semi-circular in shape with the diameter of about one foot was placed on a table. This was made slightly wet so that the mollusc could easily crawl over it. On this, a glass-vessel B, about 10 cm. in diameter and 3 cm. in height was placed and filled with water to the depth of about 1 cm. Various articles C, D., F, and G among which a small dissecting-dish C inverted and tilted up by a small box D was very conspicuous were placed in the quarter toward which the animals were expected to move.

100 individuals* out of about 200 which had previously been used in a similar experiment were picked up at random and placed in the glass-vessel B. Light was shining from the two windows N and E placed at a right angle to each other. This was at 2 P.M. (Aug 6). Almost immediately individuals started in the direction of the arrow BH which represented the direction of the least light, climbed over the edge of the glass-vessel B and crept over the glass-plate A in the same direction. Before long the vessel B was nearly empty. At 5 P.M. three and half hours after the commencement of the experiment, the individuals were disposed as follows :—

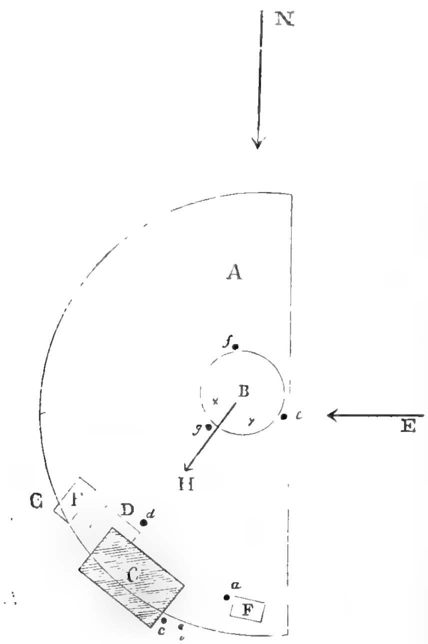

Fig. 1.

Remaining in the dish B.	8
At the spot *a*	1
At the spot *b*	1
At the spot *c*	6

* It is possible that in earlier experiments there was some mixture of the individuals of *L. sitchana*.

At the spot *d*	5*
At the spot *e*	1
At the spot *f*	1
Under the inverted dissecting-dish C.	78
Total...	101

The whole arrangement was left intact during the night, but when observed next morning (Aug. 7), no change was visible. In the course of the same morning, one more got out of the glass-vessel B, and placed itself at the spot *g*.

Nearly all the individuals that got out of the glass-vessel B, did so between the lines marked *x* and *y*, i. e. at the arc turned toward the darkest corner of the room. Only three or four got out at the other points (*e* and *f*).

It is clear from the above table that by far the largest majority (90%) of the individuals started toward the part that appeared darkest, and a large portion of this (78 individuals) hid themselves under a shaded cover.

Experiment 3 (Aug 6):—A number of individuals was placed in a glass-vessel (similar to that marked B in Exp. 2). One side of this was then tilted up by a number of glass-slides (Fig 2) so that the water in the vessel was deepest toward the darker side of the room. The result was that most of the individuals got over the edge at the darker arc in spite of deeper water on that side.

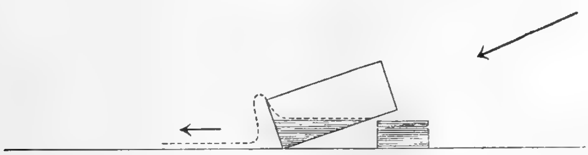

Fig. 2.

After making several more experiments of a more or less similar nature and purpose as the above two, it occurred to me that this property

* One of these got out of the glass-vessel B at the north-west point, crawled about on the glass-plate toward the north and then finally came here.

of negative phototaxis shown by these molluscs must necessarily lead them to move landward instead of sea-ward in their native habitat, and must lead them to act as if they had a notion as to which way lay the land and which way the water. Accordingly I walked along the shore-line, carefully observing how light struck my eyes. There could be no question as to which gave out more light: wherever I might put myself along the shore, (except on detached rocks) there was always more light facing the sea than when facing landward. In order to test this point further, I tried the following

Experiment 5 (Aug. 7):— An oblong flat glass-dish was made by erecting narrow strips of glass along the edges of a window pane about 35×30 cm. and by holding them there by putting a mass of putty outside them. This I took to Nakōzaki, a place near the Station. The dish was placed on the rocky and sandy beach with its longer axis as a normal to the beach-line and as nearly horizontally as possible (Fig. 3). The glass-dish was made just a little wet by having a thin layer of sea-water. 100 individuals were picked off at random from the rocks near about and placed in the center of the dish. The time was 2:48 P. M. (Aug. 7) and the midsummer sun was pouring down its rays from overhead equally all over the plate. At 4:30 P.M. the individuals were distributed as follows:—

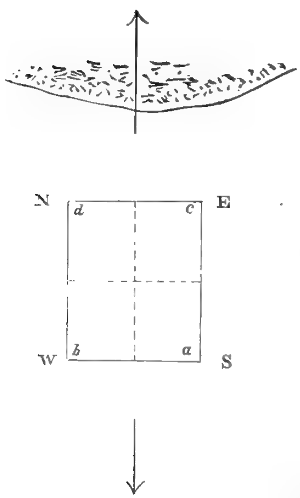

Fig. 3.

The quarter with the corner *a*	6	24
The quarter with the corner *b*	18	
The quarter with the corner *c*	39	66
The quarter with the corner *d*	27	
	90=	90
Missing	10=	10
Total...	100=	100

Thus the half of the plate turned toward the land which appeared naturally darker on account of bushes, grasses etc, had nearly three times as many individuals as the half turned toward the sea. When it is recollected that the sun was at the time shining from the zenith, the reaction must be considered as very decided. It was evident that whether these molluscs have other means or not, the property of negative phototaxis alone must induce them to crawl landward and to make them behave as if they knew the differences between the land and the sea.

There was another series of experiments which I shall detail next.

Experiment 7 (Aug. 7):— In a square aquarium about a foot on each side (Fig. 4), two glass-plates A and B* were placed, forming an inclined plane as shown in the annexed woodcut of the side-view. A third glass-plate C was put on the upper edges of the aquarium against the inclined plane so as stop any mollusc that may come up the incline. The whole was placed so that light was falling on the inclined plane in the direction of the arrow in the lower figure.

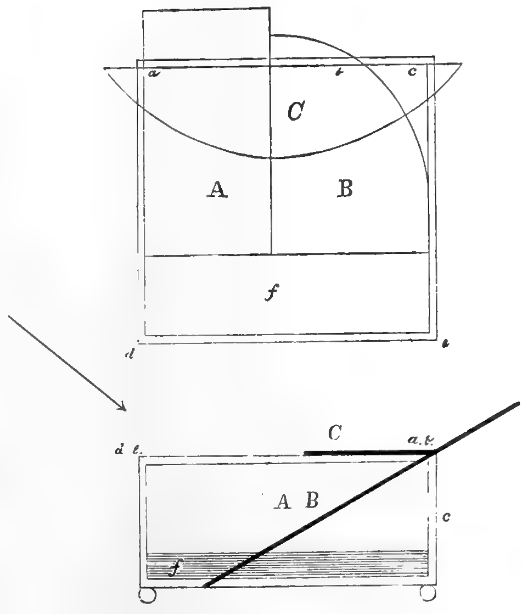

Fig. 4.

The upper figure is the horizontal view; the lower figure is the side-view.

A large number of shells was placed at the spot *f* on the bottom of

* There was no reason why two plates should be used instead of one. This was rather a drawback than otherwise. Moreover one of the plates, B. was not a whole one. Only these were the best arrangement I could make at the time. I must apologize for the crudity of arrangements in my experiments.

the aquarium. It was intended that water poured drop by drop from above should gradually submerge them and their action under the condition was to be observed. But the aquarium and the glass-plates being somewhat wet, the shells all began to march up the inclined plane, as soon as placed there, toward the dark side and was only stopped by the third glass-plate C.

[In another experiment (Exp. 9) with exactly the same arrangements as the above, every thing was thoroughly dried and the shells were also dried in the sun. 200 individuals were placed at 11 : 30 A. M. (Aug. 8) at the point *f* and water was poured to a slight depth. At 4 P. M. distribution was as follows :—

Remaining at *f*	12	(These were probably weak half dead ones.)
At the corner *d*...	3	
At the corner *e*...	5	
At the vertical back-wall *c*.	13	(Several of these had probably slid off the plate B.)
Crept up the incline and stopped at *ab* ...	167	
Total	200	

This shows that an overwhelming majority goes up the incline toward the dark side.]

On the next morning (Aug. 8) the position of the aquarium was reversed, bright light being made to strike on the *abc* side. This induced some that were at *ab* to move down the incline and to creep across the depth of water and to gain the *de* side. It was noticed that in coming down, as soon as they struck water, most of them hesitated and crawled horizontally along the water's edge. They showed reluctance to enter deep water, and seemed only driven by negative phototaxis which appeared to be a stronger instinct with them. Some indeed crawled straight across to the *de* side. Some others, while crawling horizontally at the water's edge got unfortunately on the under side of the inclined glass-plates. Most of the individuals, however, did not stir and held on to the *abc* side. Even the bright sun-rays induced only few to move down.

The foregoing experiments showed that it was easy enough to drive these molluscs up an incline, i. e. from the sea toward the land but nothing indicated what induced them ever to come down again in state of nature, for the change of the light and dark sides, such as was brought about in Experiment 7, can never take place in the native habitat of these molluscs. After these experiments, therefore, two questions confronted me :—

(1) What makes these molluscs scatter themselves somewhat uniformly over rocks in state of nature, instead of being amassed together at the highest tide-mark as at the line *ab* in the Experiment 7 ?

(2) What induces these molluscs to come down toward the sea after they are once driven up toward the land ?

The first question was comparatively easy of solution, while the second puzzled me considerably. The following experiments will elucidate these points.

Experiment 10 :— In Experiment 9, there happened to be two glass-slides stuck on the glass-plate B, and it was noticed that these obstacles stopped for more or less lengths of time some of the molluscs that were going up the incline, and one actually settled there. Acting on this hint I made the following changes in the arrangement. I took the smooth glass-plates A and B (replacing B with a whole one) and poured on them plaster of Paris mixed with coarse sand making an irregular uneven rough surface as nearly resembling the rocks on which these molluscs live as I could make them. These were then placed as before inclined against one side of the square aquarium. About 150 individuals were placed at the spot *f* as before, and a little water was poured until the bases of the glass-plates were just touched. The result was very striking. The molluscs started up the incline as before, but instead of marching straight up to the line *ab* and of being stopped only by the glass-plate C, they now scattered themselves all over the glass-plates A and B. They availed themselves of the nooks and corners produced by the rough surface and settled down in them. Fig. 5, A shows roughly the

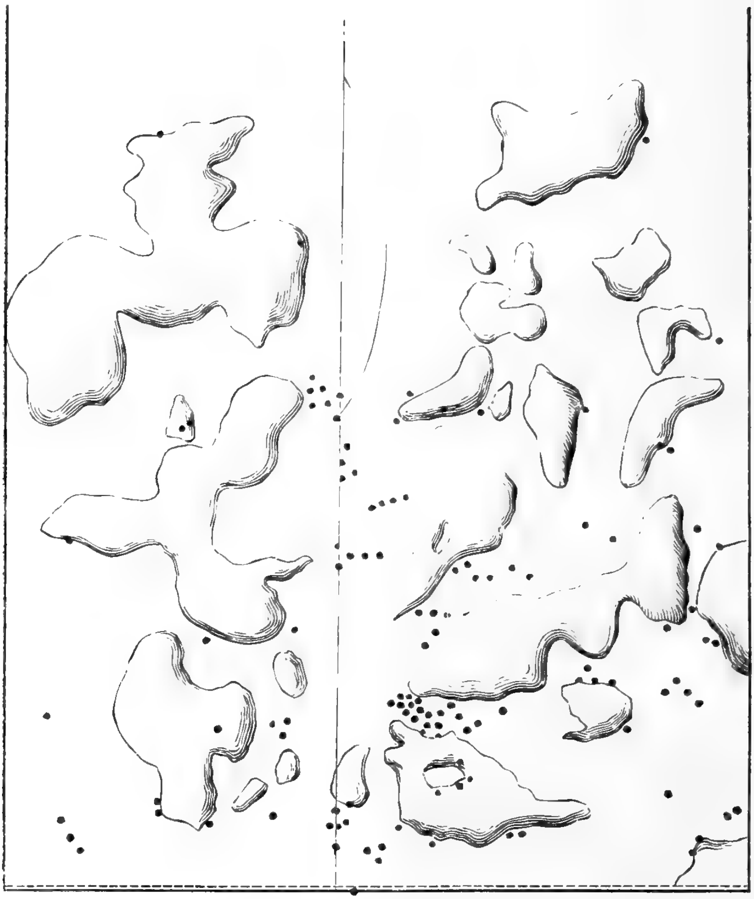

Fig. 5, A:—The dotted line marks the level of water, and the black dots show the positions in which the molluscs settled down.

unevennesses on the glass-plates A and B, and how the molluscs settled themselves on this first day. It will be noticed that they are most abundant in valleys and were more numerous in the lower half.

On the next day no spontaneous changes were visible: so the level of the water was raised to that indicated by the dotted line in Fig. 5, B. All the molluscs that were threatened with submergence marched upward again; a few were finally left at the water's edge but none below it. On the third day, the level of water was raised to that given in Fig. 5, C. The molluscs shifted their positions upward for the third time. A

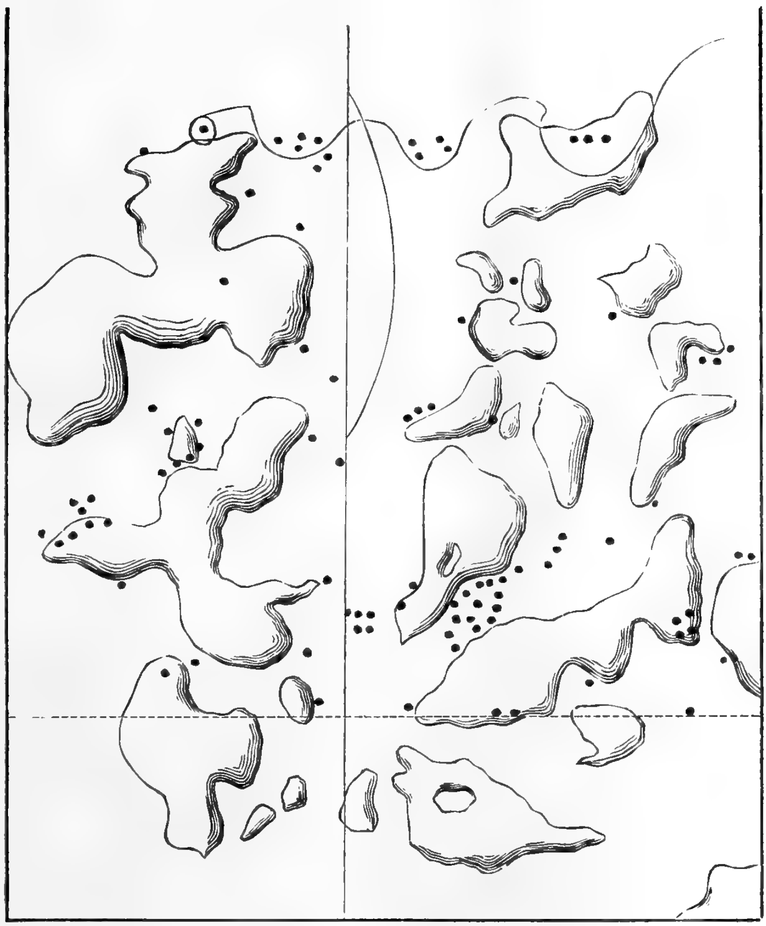

Fig. 5, B.

ralu diminution observed in the number of individuals is due to two causes: one was that a wet roll of paper was kept at the junction of the glass-plates A and B with the glass-plate C and many reaching there hid themselves in the folds of the roll and could not be observed. Secondly, many slid off the glass-plates at the sides and went to the vertical back-wall *c*.

This experiment seemed to answer the first of the two questions given above. *It was evident that the reason why the mollsucs scatter themselves uniformly over rocks is because the rocks are very uneven and rough, and there were nooks and corners in which the animals could hold*

Fig. 5, C:—The break in the dotted line is due to a slight shifting of the glass-plates. The loop indicates that the mollusc on that elevation was above the water-level.

and conceal themselves.

The conditions given in Fig. 5, C was left intact for two days. During the interval, not a single mollusc stirred. On the fifth day (from the beginning of the experiment), water was again lowered to the level of Fig. 5, B. with the hope that there might be some downward movements of the molluscs. But none stirred, and although the whole was left untouched for four days more, no movement was visible.

Under what conditions, then, the molluscs moved downwards, remained as much of a mystery as ever. I was greatly puzzled. At one

time, I thought, these molluscs left by the receding tide and dried by the sun were mechanically blown down by wind or washed down by rain. But this idea could not be entertained for any length of time, as the following facts show. I marked out with paint areas on rocks around certain counted numbers of individuals, which were also marked with paint. On visiting these areas day after day, it was noticed that some individuals had clearly moved downwards out of the area. Here is an example of such an observation :—

Station XI. Established Aug. 30 A. M. 20 individuals within the circumscribed area.

Aug. 31, A. M. No change.

Sept. 1, A. M. Tide has touched the area. Five individuals have wandered out of the area but none more than 8 cm. 3 of these have moved *downwards below the area.*

Explanation must then be sought elsewhere. Meanwhile I had accidentally discovered the fact that if a stream of water is dropped rather rapidly from above on these molluscs, *some of them begin to move down, after the stream is stopped.*

Here is a case. :—

Experiment 11 (Aug. 29) :—Arrangements as described in Experiment 10. In fact they had stood over from that experiment and the individuals were scattered over the artificial plaster-of-Paris rock as in the last phases of that experiment. I now rigged up a siphon arrangement by which water could be poured on the molluscs. Dropping of water was begun at 8 : 30 A. M. and continued for 20 minutes. There were about 56 individuals subjected to the action of the stream. When the stream was stopped, 15 individuals *moved distinctly downwards.* Most of these 15 descended to the water's edge, some rather sinuously, and then wandered horizontally along that edge. 2 made a loop and went up again. 6 unfortunately slid off the glass-plates and went to the vertical back-wall *c*. About 12 of the 56 individuals moved upwards.

The stream, therefore, induced some to move *down* toward the *light-*

er side. The same stimulus, however, caused some others to go further upward toward the dark.

Another case :—

Experiment 12 (Aug. 30) :—The same arrangement as before. Water sprayed on for 30 minutes on a number of individuals. After 10 minutes for another 3 minutes. After 40 minutes the reaction nearly ceased. Then water sprayed another 3 minutes.

During that time, 2 individuals were observed to go upwards.

Several individuals were seen moving down.

One of these down-moving ones was picked up and as quickly as possible placed in the center of the flat dish described in Experiment 5. It crawled toward light, i. e. was *positively phototaxic.* The dish was turned around 180 degrees. The individual turned around also and resumed its *positive* course. It made no difference whether the light side of the flat dish was lifted and made higher than the darker side.

A second individual which was also moving down the incline was quickly put in the center of the same dish. This became *negatively phototaxic.* The process of moving this one had probably disturbed the condition, whatever that may be, under which it was moving *down* the incline in its *positive* course. The first individual and this one were moving in two opposite directions on the same dish, at the same time.

A third individual also moving down was similarly transferred to the flat dish. It became *negatively* phototaxic. On being placed back on the incline it marched upward.

A fourth also going down was similarly transferred. This was *positively* phototaxic. Put back on the incline it *went down.*

A fifth individual, going down, removed on the flat dish was *positive.*

A sixth (*L. sitchana* var. *brevicula*), going down, removed on the flat dish, *negative.*

A seventh, going down, removed on the flat dish, *positive.*

An eighth, going down, removed on the flat dish, *negative.*

A ninth, (*L. sitchana*, var. *brevicula*), going down, removed on the flat dish, at first turned about as if it could not make up its mind, and then became *negative.*

The results of these experiments were confirmed by another.

Aug. 30, 8 A. M. Went to Nakōzaki. A group of *Littorina* lying attached to a nearly vertical face of rock, just above the water level was chosen, and water was splashed on with hands for about five minutes. On splashing being stopped, many began downward movements and reached water's edge in about half an hour. One went upwards.

Two other lots of these shells (A) and (B) near highwater mark were selected. First, some individuals from the both groups were tested in water and found to be *negatively* phototaxic. After this, water was splashed on them, on one (A) 50 bucketfuls. In one group (A), no movements followed. The shells could not be roused, so to speak, from their quiescence. In the other group, (B), two were distinctly seen to go downwards, while four went upwards. Drying of rooks, however, stopped the motions of all the individuals quickly. First splashing made a few roll down.

It seemed now tolerably certain to me that the molluscs in being driven upward by the advancing tide must necessarily be subjected for hours to the splashing of little waves, and therefore when the receding tide leaves them comparatively quiet, they must become positively phototaxic and move down toward the sea. I therefore went to Nakōzaki and made the following observations.

Station XII. Aug. 30, 8: 30 A. M. Tide receding. An area circumscribed on a vertical face of rock around 20 individuals which were also marked.

5 P. M. Tide was just advancing on the lowest limit of the somewhat squarish circumscribed area. Individuals had not stirred from their positions in the morning. As tide arose, the individuals were gradually driven upwards. Movements of the animals took place, when splashes of waves receded and left them momentarily quiet. 3 individuals remained below submerged, but others crawled up higher and higher and were driven out of the circumscribed area, until the individuals were about 5 cm. above the highest point of the circumscribed area. This was at 6: 20 P. M. when I had to leave. The tide could not have risen much higher and receded during the night.

Aug. 31 :—When I went to the spot next morning at 5 A. M., tide was rising again but had not yet reached the circumscribed area. I was able to recognize 17 out of the 20 individuals which had originally been in the circumscribed area, with one other doubtful one, distributed as follows:—

1 was in a crevice about 25 cm. to the left (looking from seaward) of the original area, a trifle below the level as when I left last night. All the rest had moved down.

4 were in the original circumscribed area.

5 were on the same level as the original area but outside it, furthest one being about 10 cm. to the right.

1 doubtful, at the same level.

7 were below the level of the original area, the lowest having gone down about 15 cm., below the lowest side of the area, at the then water's edge.

It was evident that after the tide receded, some of the molluscs went down seaward. I have further notes on the same area as follows :—

Aug. 31, 8 : 45 A. M. Nearly full tide. The tide did not rise as high as the preceding evening. It affected only the lowest individuals which moved up about 15 cm.

Sept. 1, 8 : 30 A.m. Another high and low tide during the interval. Individuals scattered but still more or less near the original area. One about two feet from it.

I will conclude with another experiment :—

There is a large rock lying near the landing place of our laboratory. When the tide was at the level of the dotted line (See Fig. 6.), I placed some individuals of *L. exigua* which were known to be negatively phototaxic at the spot A of this rock a little below the water line. The spot was about ten feet from the high bank near the landing place. The question was whether these individuals would go in the direction of the high bank or toward the higher part of the same rock which was turned away from the general mass of land. There was no ambiguity about the answer. As soon as they were placed there, they started in the direction of the arrow toward the higher part of the rock A.

I now took some of these negative ones to a spot on a ledge of rock

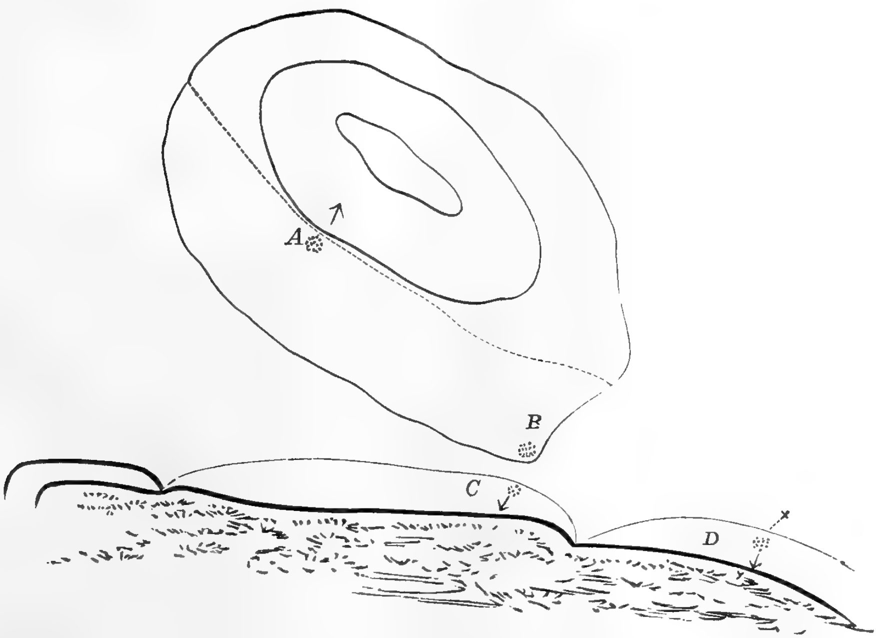

Fig. 6.

D. Here the depth of water was about 15 cm., but considerably deeper at the very base of the bank at y, while it was shallower in the direction of x :—

1 went up in the direction of x.

3 started toward the land in spite of a greater depth of water. 1 of these crossed the deepest part to the side y. The second went as far as the deepest part. The third to a somewhat shallower place.

2 did not stir at all.

Several individuals that were moving upwards at A were placed at B and C several inches deep in water. There was a deep cut abut 2 feet deep in the rock between B and C. B was 2 feet from the bank. Individuals placed at B did not stir at all. Of those placed at C, one went in the direction of the bank. The others did not stir at all.

I take it that in this experiment, A was out of the influence of the shade of the high bank, at least from the molluscan standpoint. Hence they went up in the direction that must have appeared darkest to them i. e. in the direction of the highest point of that rock, although this was no more than a few inches in height. B, C, and especially D are in the shade of the bank : hence most of those that stirred at all went landward, even if they had to cross water considerably deeper than that in which they were placed. In B, the darkest part was toward the high bank but water being very deep must have influenced the molluscs in some way so that they did not stir at all.

Once a lot of *Littorina sitchana* var. *brevicula* kept in a glass-bottle for about ten days showed positive phototaxis for several days continuously. This I can not account for in any way, as this species also is ordinarily negatively phototaxic. Nor could I induce other lots to act in the same way by subjecting them to a similar treatment.

CONCLUSIONS.

1. *Littorina exigua* shows a strong negative phototaxis under ordinary circumstances. That it is not negative hydrotaxis is shown by Exp. 3.

Note. This property enables the mollusc to creep up from the sea towards the higher level which corresponds in most cases with land, but in cases of detached rocks may be away from the general mass of land.

2. *Littorina exigua* shows a disinclination to be submerged. This is proved by the fact that a rise of water drives the mollusc upward, as well as by the fact that if the mollusc touches the water's edge in coming down, it hesitates to plunge in, and in many cases travels horizontally along the edge as if in search for a better or more comfortable route. In Experiment 11, two actually turned back and went upwards again.

   Note. When negative phototaxis and negative hydrotaxis act together, the mollusc is driven upward without hesitation. When these two properties are acting against each other as in the case of Experiments 3 and 7, or at D, Fig. 6, negative phototaxis seems to be stronger and to overcome negative hydrotaxis, at least in small depths. In greater depths, the result is not entirely clear, as at B. Fig. 6, where the mollusc did not stir.

3. *Littorina exigua* are in nature scattered over rocks, because there are unevennesses in rocks which provide them with holes and crevices to settle down in. On smooth glass-plates, they move on until they are stopped by some obstacle which they can not overcome.

4. When *Littorina exigua* is splashed on by water, for some length of time, as by waves in rising tide or artificially by a jet of water, and then is left quiet, it may become *positively phototaxic* and then it goes down from land soward the sea. That this is phototaxis and not hydrotaxis, is shown by the hesitating manner which these exhibit on touching water's edge, in one case at least, such dislike seeming to send the animal upward again (Exp. 11). This property is not as unfailing and strong as negative

phototaxis, and seems to disappear soon and on slight disturbances.

5. While disliking deep water, *Littorina exigua* can not live on dry surfaces. It must have a cartain amount of moisture to crawl and probably to feed.

   Note. This is the reason why the mollusc left dry at the highest tide-level sleeps on, so to speak, unmindful of the boiling heat of the midsummer sun, till the next spring-tide comes round again in a fortnight and wets the region about.

6. Individuals of *Littorina exigua* do not probably wander about over any large extent of space.

   Note. One individual which I marked, probably in August or at the latest, early in September, I found, had not stirred from the identical spot nearly four months later, on Dec. 27, 1900.

What is said here of *Littorina exigua* is probably true to a large extent of the second species, *L. sitchana*, var. *brevicula* and of other species found elsewhere.

In thinking over the facts thus brought out, it seems to me that the facts under the second and fifth headings are probably the primary ones. That is, the animal lived by preference on slightly moist surfaces of rocks. Whenever the water became too deep for its comfort, it would naturally try to escape toward shallower places more adapted to its life. This they found, they could do by guiding themselves by their eyes toward the quarter that appeared darkest to them. *We* know that this corresponds with the direction of land, but it is not likely that the mollusc can have any conception of the things presented to our mind by the words, land and water. To the mollusc the dark quarter represents the comfortable quarter, and nothing more. In course of ages, by the process of natural selection, the mollusc would acquire the property of negative phototaxis which has in actuality become so strong that even when the conditions which originally made this property useful are artificially reversed, that

is, when the dark quarter is made to correspond with the deep water, it plunges in, unconscious of any disadvantage that might follw. It knows, also, that after it is beaten by waves for hours—known to us as due to rising tide—and then is left quiet, it ought to move down, if it wishes to feed perhaps, and if it does not desire to be left dry—as, *we* know, would surely follow on account of receding tide. Thus, even when judged from our standpoint, the actions of the mollusc are rational and easily comprehensible. But we must not of course for one moment suppose that to the mind—or whatever there is that represents our mind—of the mollusc there is present such conceptions as land, water, tide &c. We must be careful not to read our thoughts into the actions of animals in studying their psychology. The mollusc probably knows instintively only to go toward dark, when water begins to splash it, and to move toward light when splashing has stopped.

While it is undoubtedly true that the environment in which *Littorina* has lived, has developed the instincts or properties enumerated above, the contrary statement is true at the present day that, given these properties it can not live in any other habitat. They limit the horizon of the animal's activity. To that extent the animal has become specialized.

Imperial University, Tōkyō.
May, 1901.

On the Lampreys of Japan together with Notes on a Specimen of Lamprey from Siberia.

BY

S. Hatta.

For some years past, I have been engaged in collecting materials for the study of the species of *Petromyzon* which occur in Japan, and of their distribution. The present notes embody the results so far obtained, and while not yet complete, will, it is hoped, prove of some interest. In addition to this, I append at the end a brief notice on a specimen from Siberia.

The materials employed in the present investigation are (a) the specimens in the Zoological Institute of the Science College, (b) the specimens in the Imperial Museum,[1] and (c) those in my own possession partly collected by myself at several localities in the year 1891—1899, and partly collected and sent to me by the undernamed gentlemen in various parts of the country, [2] to whom my best thanks are due :—

Prof. A. Oka, Mr. S. Honda, Mr. S. Fujishima, Mr. J. Nakanishi, Mr. T. Yubuki, Mr. T. Yasuye, Mr. K. Andō, Mr. N. Takahashi, Mr. K. Okamura, Mr, S. Morohashi, Mr. T. Kitahara, Mr. T. Awoyama, Prof. J. Hara, Mr. T. Nozawa, Mr. T. Yamanaka, Mr. M. Yamaoka, Mr. Y. Yanagisawa, &c

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1) For the free access of these collections I am indebted to Prof. Mitsukuri, the Director of the Institute, and Prof. Ishikawa, the Director of the Natural History Department of the Museum.

2) I am also indebted to the undermentioned gentlemen, from whom I received the important informations on Lampreys :—
Mr. S. Onishi, Mr. K. Furusawa, Mr. S. Honda, Mr. Y. Nakamura, Mr. Y. Nawa, Mr. K. Niwa, Mr. K. Kato, Mr. H. Kato. Mr. T. Hata, Mr. T. Nozaki, Mr. T. Ogasawara, Mr. K. Ogura, Mr. T. Ito. Mr. Y. Watanabe, Mr. T. Takeshita, Mr. S. Hattori, Mr. S. Kajiya, Mr. K. Ishikawa, Mr. K. Fujiwara, Mr. M. Saneyoshi, Mr. N. Hayashida, Mr. T. Yamanoutchi, &c.

A. *On the Species of the Japanese Lampreys.*

A collection of the Japanese Lampreys falls naturally into two groups ; (1) a larger form measuring 39.0—50.7 cm in length and (2) a smaller one having length of 8.0—15.6 cm. The larger form is undoubtedly the one described by v. MARTENS under the name of *Petromyzon japonicus.* Unfortunately I have been unable to see the original description. GÜNTHER [1] makes the following remark on it: " *Petromyzon japonicus*, Martens, Wiegm. Arch. XXXIV, p. 3, does not appear to be specially distinct from *P. fluviatilis.* The dentition in both is extremely similar, only the Japanese example has an additional transverse series of small teeth behind the mandibulary tooth. The figure accompanying the description of *P. japonicus* is incorrect and I am indebted to Professor Peters for re-examination of the typical specimen " (p. 504)

PROF. JORDAN has called it, in his " Preliminary Check List of the Fishes [2] of Japan, " *Petromyron japonicus* following MARTENS' nomenclature.

As GÜNTHER states, this form of the " Japanese Lamprey closely resembles *P. fluviatilis*, that is, the position of the fins, the coloration of the body, the branching mode of the marginal tentacles of the suctorial disk, the maxillary tooth, the lingual tooth, the teeth of the suctorial disk, the structure of the brain (see below), &c. all agree with those described in *P. fluviatilis.* But there are found two points of constant differences :—

(1) The first point has already been noted by GÜNTHER. He notes " an additional transverse series of small teeth behind the mandibulary tooth." I would replace the word "behind" with the word " inside," because this series of the teeth is found immediately *inside* the mandibulary tooth-plate. It should be noted that these teeth which are 3—4 in number are, so far as I am aware, not yet enough hardened to deserve

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1) GÜNTHER. Cat. of Fishes, vol. VIII.
2) This Journal. vol. III, pp. 31—159, 1891.

the name of teeth, but are the merely hardened horny projections of the skin.

(2) The number of the cusps of the mandibulary tooth-plate is described in *P. fluviatilis* as being seven or about seven. In the Japanese species, this tooth-plate has constantly six cusps of which the cusp at each lateral extremity of the plate is bifurcated.

I propose, therefore, to regard the Japanese form as a distinct species and to call it *Lampetra* [1] *japonica*.

This Lamprey does not occur in all the parts of the empire, but is limited to certain localities (see below).

There has not been published any description of the smaller Lamprey [2]; it differs from the larger form just stated not only in size but also in the following essential characters :—

(a) The suctorial disk is protruded more than in the larger one ;

(b) The tooth-cusps are less prominent and more obtuse than in the larger form, and the series of the teeth outside the mandibulary tooth-plate consists of a lesser number than in the larger form ; the cusps at lateral extremities of the mandibulary tooth-plate are not bifurcated ;

(c) The first dorsal fin is not separated by a space from the second dorsal, but there is only a notch befween them ; the anal fin in the female attains in the spawning season a considerable height ; this is called by S. H. Gage the fin-like appendage ;

(d) The labial tentacles are mostly palmate ;

(e) The skin is dark brown and shows faint irregular spots. This species is thus in the external characters very close to *P. planeri* (Bl.). In addition to these, two species show a great similarity in the external configurations of brain (see below). But (1) the smaller size and (2) the smaller number of the mandibulary tooth-cusps are the constant

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1) For the reason brought out further on, I have adopted the generic name *Lampetra* for this species.

2) V. Martens only touches it in his " Die Reise nach Ostasien."

differences which distinguish it from the latter. It must, therefore, be regarded as a distinct species; and I have great pleasure in calling it *Lampetra mitsukurii* in the honour of PROF. MITSUKURI.

The size varies within certain limits; it is not infrequent that the individuals from some localities are double those from others.

The American Brook Lamprey, *Lampetra wilderi* (GAGE)[1, 2] is very close to this species; it is, as it seems to me, probably its nearest ally[3].

I may perhaps be permitted to add a few words in regard to the brain of two Japanese species of Lamprey. I find that the adult individuals of the both species are remarkably alike in the external configurations of their brain, which are again very close to those of *P. fluviatilis* of Europe. (see AHLBORN's[4] figs 4—6). Therefore, if AHLBORN's statements and figures (figs. 1—3) on *P. planeri* be trusted which maintain some difference between its brain and that of *P. fluviatilis*, they might be taken to be opposed to the idea of a near affinity between *P. planeri* and *L. mitsukurii* mentioned above. But there is a strong reason doubting the accuracy of AHLBORN's results. It appears to me that the brain of *P. planeri* as given in his fig. 1 is that of a young individual, for the brain obtained from the oldest Ammocoetes stage of the smaller Japanese species shows very much the same configurations. This doubt is further confirmed by the fact that the figures (figs. 5 & 6) of the brain of *P. planeri* given by WIEDERSHEIM[5] agree closely with the brain of *L. mitsukurii* of Japan.

I accept mainly on account of the brain configurations just stated, the views of recent writers in maintaining that the genus *Petromyzon* should be split into two: retaining the old name *Petromyzon* for *P.*

1) GAGE, The Lake and Brook Lampreys of New York: WILDER's Quarter-century Book, 1893.

2) JORDAN AND EVERMANN, Fishes of North and Middle America, Pt. I, 1899.

3) *P. marinus* has not been hitherto met with in Japan.

4) AHLBORN, Untersuch. ü. d. Gehirn der Petromyzonten; Zeitschrift f. w. Zool., Bd. XXXIX, 1883.

5) WIEDERSHEIM, Das Gehirn von Ammocoetes und Petromyzon planeri; Jen. Zeitschrift, Bd. XIV, 1880.

marinus and assigning GRAY'S name *Lampetra* to the portion represented by *fluviatilis, planeri, mitsukurii, wilderi*, &c.

B. *Distribution of the Lampreys in Japan.*

The smaller Lamprey, *Lampetra mitsukurii*, is found in almost all localities of the empire, while the larger form, *L. japonica*, is limited to the rivers and ponds on the slope facing the Japan Sea on the main island (the Hondo); the latter is especially abundant in the Shinano River, the Mogami River, the Omono River, the Jintsu River, the Lake Kawakita, the Kozan Pond, &c. It has been maintained by some persons that the larger Lamprey is occasionally met with in the marshy regions of the Kwanto-Plain and in the mouth of the Kiso River and of the Kitakami River and their adjacent waters. As these localities all belong to the Pacific side, I have been at great pains to obtain the specimen from them, but all my efforts were unfortunately so far proved fruitless.

Let us now try to explain this peculiarity in the distribution of the Lampreys on the main island.

As is well known, the long chain of the islands, of which our empire is composed, extends from the parallel of about 52° north to the parallel of 22° with an oblique north-east or south-west direction. As regards the main island, the long range of high mountains running lengthwise in the central part constitutes the water-shed which divides rivers into two sets of systems: the rivers on the slope facing the Asiatic Continent empty their water into the Japan Sea, and the streams on the opposite slope flow into the Pacific Ocean. The rivers on the Pacific slope have in general a very steep incline, and their waters rush down in torrents after heavy rains, and in most of the rivers, almost drying up or dwindling into mere threads of water at other times. Thus their bed consists, in most parts, of sand and gravel. On the contrary, the rivers on the opposite side are less steep, and their bed is muddy. These topographical conditions exert, it seems to me, a great influence upon the distribution of Lampreys in Japan, as the following considerations will show.

Sluggish creatures like the Lampreys can not naturally flourish in rapid currents even when other conditions are favorable. Thus the larger Lamprey which inhabits preferably the muddy bed of rivers, lakes, ponds, and river-mouths ; and in the spawning season alone ascends rivers to deposite eggs on the sandy bed of their tributaries, would not find such conditions in the rapid streams of the Pacific slope. The poor creatures could not be able to hold themselves. This, it seems to me, sufficiently accounts for their absence from the river systems of that side.

On the other hand, the smaller Lamprey does not live in rivers, but generally in small streamlets between the fields, in springs, or in small canals near towns. The animal being thus independent of rivers their habitation has been able to extend itself all over the main island wherever other natural conditions allow them.

There will be nothing to clash with the views put forward here, if the larger Lamprey should be found hereafter, as is very likely, in marshy regions of the Kwanto-Plain as well as in estuaries with the muddy bed as the mouth of the Kiso River and of the Kitakami River, although these localities belong to the Pacific side. On the contrary, such a discovery could go a long way in proving the correctness of the above hypothesis.

Let us now turn to the examination of other islands : Shikoku, Kyūshū, and the Hokkaidō, &c.

Geologists tell us that the inland sea (the Setouchi-Umi) between Shikoku, Kyūshū, and the main island was brought about by *faults* and constitutes a geological moat. The distribution of the Lampreys affords the excellent evidence for this view. The two great southern islands, Shikoku and Kyūshū, show, as regards the distribution of the Lampreys, the same condition as the Pacific side of the main island ; on these islands the smaller species alone is found ; they are to be regarded, in this respect, as belonging to the Pacific slope.

In the Hokkaidō, only the slope facing the Japan Sea has been explored ; in this part, the larger as well as smaller forms occur, just as

in the corresponding slope of the main island. The former species is found in the Ishikari River and the Teshiwo River, whilst the latter form is met with abundantly in streamlets in that part of the island.

Sado, a small island in the Japan Sea off the Peninsula of Noto, is very interesting ; it is the same, as to the *Petromyzon* distribution, as the localities on the opposite shores of the main island, viz : Noto, Toyama, Niigata, Sakata, &c.

In the Ryūkyū (Loochoo) islands, the Lampreys have not yet hitherto been found; these seem to be destitute of Lampreys.

I have not yet explored the Lamprey fauna of Formosa ; this I hope to deal with on a future occasion together with that of the opposite coast on the Asiatic Continent.

If the above assumption be correct, it is clear that the distribution of the Lampreys in our empire is dependent on the topographical features. The influences of other natural conditions, if such truly act apon the life of the animal, are very little as regards the distribution.

C. *On a Specimen of the Lamprey from Siberia.*

I have recently received a specemen of the Lamprey from Eastern Siberia, which was caught in a brook callad Pervaya Rechka, a tributary of the Amur River, not far from the Seaport of Vladivostock. It was taken last summer and sent to me by my friend Mr. ABENO who has resided there for about seven years. He writes to me that the Lamprey is very rare in the neighbourhood of the city, and that he has seen only two individuals during that time of his residence.

The specimen is just transformed individual and is preserved in good condition in alcohol. It measures 15 cm ; therefere, it is smaller than the larger specimen of *L. mitsukurii* and larger than smaller ones among it. The second dorsal fin is continuous with the caudal ; the first and second dorsals are separated by a deep notch. The first dorsal is 3 mm high, while the second is 5 mm in height. The distance from the snout to the anterior limit of the first dorsal is 7 cm. The head is about as long as the branchial region or the thorax. The supraoral lamina is

provided with 2 well separated obtuse cusps ; the infraoral lamina possesses 6 obtuse cusps. 3 bicuspid teeth are found on each side of the gullet. Other buccal teeth are simple and describe a circle immediately inside of the fringe of the labial tentacles. Each labial tentacle is palmate, terminating in a blunt point. The specimen is female, but wants the anal lobe (the fin-like appendage), probably owing to being caught out of the spawning season. Coloration is quite like the Japanese specimen of *L. mitsukurii*.

The specimen is thus very close to *L. mitsukurii* of Japan ; in fact, both are, I think, of the same species. It is, therefore, also very close to *L. wilderi* (GAGE) of North America.

Let as now examine other species of the Lamprey of East Siberia.

I have not seen the description of the Lamprey of Kamtschaka by PALLAS;[1] but by the account of DR. JORDAN,[2,3] I know that two species of the Lamprey, *Entosphenus camtschaticus* (TILESIUS) and *Lampetra camtschatica* (PALLAS), are found in Kamtschaka. On the former species he remarks : " A larval lamprey obtained by STEJNEGER in the Paratunka River, near Petropaulski, Kamtschaka, is apparently of some species of *Entosphenus*. It can not be distinguished from the larva of *Entosphenus tridentatus*, though the adult may show peculiar characters " (p. 434). *Entosphenus tridentatus* is, according to JORDAN, common southward along the coast of Unalaska. The auther puts the second species (*Lampetora camtschatica*) synonymous with *Lampetra aurea* (BEAN), which is found also in the Yukon River and other streams of Alaska. Thus the two species, *Entosphenus tridentatus* and *Lampetra aurea*, occur common on the two continents, Asia and North America, separated by the Behring Strait.

Lampetra aurea is, according to JORDAN, very close to *Petromyzon fluviatilis* of Europe, and therefore, also to the larger Lamprey (*L. japonica*) of Japan.

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1). PALLAS, Zoographia Rosso-asiatica, 1767.
2). JORDAN, Report of Fur-Seal Investigations, Part. 3, 1899.
3). JORDAN & EVERMANN, Fishes of North and Middle America, Pt. I., 1899.

My friend Mr. UYEDA in Nikulaevsk informed that there are found Lampreys abundantly which much resemble the larger Lamprey of Japan ; these may be of the same species as *Lampetra camtschatica* (PALLAS) or *L. aurea* (BEAN).

Thus together with *Lampetra camtschatica* which is the same or at least very close to *Lampetra japonica* of Japan, the present species is represented on the Japanese Island. I do not hesitate in concluding, therefere, that the coasts round the Okhotsk Sea and the Japan Sea show, with regards the Lamprey fauna, a uniform character with exception of *Entosphenus tridentatus* which is wanting in Japan.

From the accounts given above, it is also true that the Lamprey fauna of Japan is connected through Kamtschaka, on one hand, with North America and, on the other, with Asiatic Continent.

I wish to express my deepest thanks to my teacher, PROF. Mitsukuri, who kindly looked through the manuscripts.

Biological Laboratry, The Gakushūin, Tōkyō.

Nov., 1900.

Gonyaulax and the Discolored Water in the Bay of Agu.

T. Nishikawa.

During the latter part of September, the streaks and patches of brownish-yellow water emitting an unpleasant odor were observed by fishermen in the Bay of Agu, situated in the southern part of the Province of Shima, on the Pacific side of the Hondo. As this "red-tide" is said to have been in former times highly destructive to the beds of the pearl-oysters which form one of the principal productions of the Bay, a great alarm was felt for the safety of the Molluscs. Fortunately, however, on the 28th of the month, a heavy storm arose and cleared the waters of the Bay, so that very little damage was actually done.

By the order of His Excellency, the Minister of Agriculture and Commerce, I visited the Bay to determine, if possible, the cause of the unusual coloration of the sea-water.

According to the observations of Mr. Mikimoto, a pearl-oyster culturist of Tadoko Island in the Bay, the surface waters on the southern coast of the Island and along the shore of Hasako, were on the 23 rd of the month densely discolored. But, when I arrived at the Island on the 25th, this discoloration of the water had almost disappeared. I was told by a fisherman that patches of discolored water were to be seen on he northern shore of Masaki Island, but unfortunately it was already twilight when I arrived there by a boat on the evening of the 25th Consequently it was impossible to distinguish clearly any coloration but by an unpleasant odor I was able to recognize the presence of the discolored water. The odor of the discolored water was similar to that which is emitted by the Algae when collected in a great quantity. On next day, I was fortunate enough to observe well such a

patch, at about half mile west of Masaki Island. It was deep brownish-yellow in color, and was 3 or 4 feet beneath the surface, forming irregular cloud-like masses, interspersed with the water of the ordinary color. The thickness of the discolored patch was 2—4 feet.

On taking a little of it into a glass-cup, it was observed that an enormous number of minute organisms swarmed in the water which was as clear as usual. There could be no question, that the discoloration of the water was due to the presence of numerous minute organisms. On examination with a microscope, it was found that the organism belonged to the Peridiniaceae. It has a polygonal shape, with an areolated shell. The anterior pole is pointed, and there are two processes, one larger than the other, on the posterior pole. The longitudinal groove is very broad in its posterior part having a conspicuous "Geissel-spalte", from which a long flagellum extends backward. Anteriorly the groove becomes very narrow and scarecely communicates with the polar opening. The left end of transverse groove in the ventral side is below the right. The chromatophores are small and numerous, brownish-yellow in color. The length of the body is 0.046 mm. and the larger process is 0. 0062 mm. long. The organism moves very actively by rolling itself on the longitudinal axis of the body. Sometimes two individuals were connected in a chain like *Ceratium tripos.*

The organism occurred in such a great abundance that it gave to the water very noticeable color and peculiar odor, 800 or even nearly 3,000 in the densest part, having been estimated to be present in a drop of the discolored water. George Murray Esq. of the British Museum, to whom the specimens were sent, has kindly identified the organism. It is *Gonyaulax polygramma* Stein. According to his statements, it is widely distributed ; he has found it frequently in the tow-nettings from the Atlantic, but he has never before seen it in such an abundance.

When disturbed, the active *Gonyaulax* gives a very beautiful phospholescent light in the dark. By keeping the discolored water in a glass bottle, the minute organisms gather near the surface of the water. After a short time, some of them sink to the bottom and the

anterior half of the shell breaks longitudinally, the contents come out from the shell, and gradually change to the spherical shape. If the discolored water is kept without any preserving reagent, the water emitts, after about a week, a pungent odor of hydrogen sulphide and the shell of *Gonyaulax* swells which is finally dissolved. The protoplasmic contents which have come out of the shell retain the spherical shape, with the chromatophores gathered in the centre. This fact is interesting, as a sample of similarly discolored water which was observed in September of the previous year (1899) in the Bay of Toba and which caused a great mortality among fishes, presented exactly the same appearance when it came to my hand from Mr. Mikimoto who had bottled it ten days before without adding any preserving reagent. This makes it highly probable that the cause of discoloration on that occasion was also *Gonyaulax polygramma*.

Besides this species of Peridiniales, the discolored water contained a species of *Ceratium* and *Prorocentrum micans*, *Ceratium tripos*, *Chaetoceras*, and some nauplius larvae were also rarely found. In the discolored water which I observed on the northern shore of Masaki Island, *Prorocentrum* and *Ceratium* were very abundant. At the same time, in the ordinary clear water of the Bay, the plankton is rich in Bacillariaceae (such as *Bacteriastrum*, *Rhizosolenia*, *Chaetoceras*) Copepoda, *Noctiluca*, Appendicularia, *Sagitta*, Nauplius and the larvae of Polychaeta and Gasteropoda. Thus, there was a great difference between the living organisms of the discolored water and of the ordinary sea-water close by. This difference seems to show that the discolored water is unfitted for the existence of Copepoda, *Noctiluca*, Bacillariaceae &c. while it seems specially suitable for the propagation of the unicellular organism, *Gonyaulax*. The chemical properties of the discolored water are probably different from those of the ordinary sea-water, but I have been unable to make investigations on the matter.

The occurrences in an excessive abundance of minute unicellular organisms, as the cause of unusual coloration of sea-water have been described before. Dr. Carter described *Peridinium sanguineum* as

causing the red coloration of the sea on the shore of Bombay. According to Dr. Whitelegge the cause of discolored water of Australia in 1891 was *Glenodinium rubrum*. In 1898, Dr. Mead discovered a species of *Gymnodenium* in the "red-water" of Narragansett Bay, Mass , U. S. A.

Usually the appearance of discolored water is accompanied by a great mortality among fishes, mollusks and shrimps. According to the observation of a pearl-oyster culturist, in the later part of August, 1899, large streaks and patches of yellowish-red water floated about with the tide in the Bay of Toba. Fishes, which were kept in baskets floating on the surface of the sea, were damaged by them. Fishermen easily caught the littoral fishes by spearing, for the fishes had became very sluggish in the discolored water. Even *Haliotis* or Ear-shell seemed to suffer.

But whether the presence of minute organisms, the Peridiniales, *per se* is the immediate cause of this mortality or not is uncertain. I put some pearl-oysters, *Meleagrina martensii*, in the most highly colored water kept in a porcelain jar. After 24 hours, I found that they suffered no injury, although the water was still swarmed with *Gonyaulax*. A simillar effect was obtained by Dr. Mead with *Gymnodenium*. I observed that the stomach of the pearl-oysters was filled with *Gonyaulax* and many empty shells were found in the intestine, which shows that *Gonyaulax* forms suitable food for the pearl-oysters, although these usually feed upon the Bacillariaceae. Thus the presence of Peridiniales, it appears to me, can not be the immediate cause of the destruction of fishes. The water which is fitted for the sropagation of Peridiniales and unsuitable for the existence of the usual plankton, is probably also unsuitable for the fish life, or the dead bodies of an enormous numbers of peridiniales sinking to the bottom decomposing and putrifying there may eventually become injurious to other organisms. This point however needs further examination.

Imperial Fisherus Bureau,

Tokyo.

Reminiscence of Holoblastic Cleavage in the Egg of the Shark, Heterodontus (Cestracion) japonicus *Macleay.*

BY

Bashford Dean.

In studies on the yolk characters of vertebrates the eggs of Elasmobranchs have always been described as presenting typical meroblastic cleavage. This character has here indeed been deemed so axiom-like that we find that the meroblastic egg is usually, if not always, made the point of departure in various works dealing with the problem of the gain or loss of yolk in eggs of the gnathostomes. Thus it has long been discussed whether the eggs of the higher classes have been capable of losing and reacquiring food yolk, or whether the eggs of the highest forms have merely lost the ancestral supply. This, however, illustrates but one line of discussion in which the embryologist has treated the eggs of elasmobranchs as irrevocably meroblastic. It is upon strictly theoretical grounds (reducing the matter to its simplest terms, for as a matter of fact segmentation has been observed in but very few forms) that the early characters of the eggs of elasmobranchs have been compared with those of other ichthyopsids. But in spite of this no one, I fancy, would have been bold enough to have prophesied that the wide difference between the typically meroblastic egg of the shark and the holoblastic egg of such a teleostome as a sturgeon might come to be bridged over within the limits, not of fossil sharks, but of recent sharks themselves. Indeed it seemed all that embryoogists could hope for, that meroblastic features should be discovered in such ancient forms of teleostomes as Lepidosteus and Amia. It was naturally, therefore, a great surprise to me to find in my studies on the development of Cestracion that there occurred in this ancient shark features which are best interpreted as

well marked reminiscence of holoblastic cleavage. And I summarize the present evidence for such a conclusion in the following notes :

In all early stages of Cestracion examined (I have notes upon upward of a hundred examples) the surface of the egg, notably the surface which keeps uppermost, and which we may call the animal pole, is traversed by a series of definite and sharply marked lines. These are disposed so conspicuously* that the observer is given the impression that he is examining an egg of Lepidosteus, magnified some 20 diameters. He thus sees at the upper pole of the egg a number of sharply defined areas, resembling the blastomeres in a late cleavage stage of Lepidosteus. He also observes a series of meridional lines passing down the sides of the egg, and diverging from one another radial-wise. These lines are next seen to become groove-like below, and then fade away toward the vegetal pole. There is also similarity in color: the region of the animal pole is of a pale straw color, the vegetal region is greenish yellow, and there is an intermediate equatorial zone, in which there is an orange or pale brownish cast. Thus far it will be seen that the resemblance to the ganoidean egg is a striking one: a more critical examination, however, brings out the facts that in the egg of Cestracion a red-colored germinal disc is present in addition to the above blastomere-like areas, and that it is situated, not in the centre of the apparent animal pole, but further down on the side of the egg. The homology of the furrows traversing the egg of this shark is accordingly not as self-evident as at first appears. Is it possible to regard them as not due to cleavages, in spite of their extraordinary resemblance ? Or, on the other hand, is the excentric position of the germinal disc to be interpreted as secondary, due, for example, to some physiological cause ? In attempting to answer these questions I was led to tabulate the reasons favorable and unfavorable for regarding the markings of the egg of Cestracion as due to cleavage characters, and this table may be quoted as follows:—

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* Their conspicuousness may be judged from the fact that they can be seen at a distance of from six to seven feet by persons of normal eyesight. They were distinguished at a distance of nine feet by a sharp sighted laboratory attendant.

Reasons for regarding the lines on the egg of Cestracion as reminiscent of holoblastic cleavage.

Unfavorable evidence.	Favorable evidence.
Such lines have never been known to occur in the egg of any other shark.	Their occurrence, therefore, is all the more significant in Cestracion, on account of the close relationship of this form with palaeozoic genera. *Cf.* also the breaking up of the egg of Chimaera into lobes or blastomeres.
They may be surface wrinkles merely.	In this event they should be superficial, more or less inconstant, and subject to change by artificial means. They are, however, not only present in all early stages examined, but they suggest distinctly the outlines of blastomeres. They show no change for as long a time as I have been able to keep alive the opened egg—a matter of 30 hours. They can be distinguished after the egg has been broken, and at such a time it is seen that they are not shallow surface markings, but that they pass deeply into the yolk; they are deepest (1. 5 mm.) at the upper pole, and become shallower as they pass downward.
They have not been traced back to the earliest cleavage lines.	The most serious objection, for as yet I have failed to secure the earliest stages of segmentation. The egg of Cestracion does not exhibit these lines shortly before it separates from the ovary. They are present when the egg is deposited (late segmentation) and they remain conspicuous for as long a time (over a month) as the yolk is uninclosed. In the earlier stages, finally, they are generally less numerous than in later ones.

They may have no constant relation to nuclear structures.

I have not as yet been able to prepare sections of the surface of the egg. The presence of many nuclei in each segment, however, would evidently have little bearing upon this point, since polyspermy undoubtedly occurs.

The germ disc is not at the animal pole, where it would be apt to be if the lines are due to cleavage.

There is evidence that the present position of the germ disc is a secondary one, for in eggs just deposited, (1) it is nearer the animal pole than in later stages: (2) there is a kind of track, whitish in color, extending from the direction of the upper pole of the egg, suggesting therefore that the disc has shifted its position, leaving a wake behind it.

Why are not these blastomere-like structures due to merocytes, like, for example, the small irregular eminences surrounding the germ disc of Torpedo or Pristiurus?

There is, however, no evidence that such distinct structures are ever produced by merocytes. Moreover, there are grounds for believing that in the older sharks these characters were less highly developed than in the more recent ones. Thus it has been shown by Rückert that the tendency for merocytes to emigrate is less marked in a shark like Pristiurus, than in the more specialized Torpedo: that in the shark the entrance of the nuclei into the yolk is less precise, and that the nuclei while in the germ disc are in general more superficial in position. We can justly infer that in so ancient a shark as Cestracion the part played by merocytes during segmentation would, if anything, be less marked than in a later form like Pristiurus.

From the foregoing analysis we can, I believe, conclude reasonably that the egg of Cestracion retains rudiments, at least, of its ancestral cleavage. But we must also admit that absolute certainty in this con-

clusion will be lacking until the origin of the above described furrows can be traced back directly into the earlier cleavages. In the mean while, however, the case is so strong a one that I think we can justly refer to the lines as expressing cleavage, and to the sharply outlined areas as blastomeres.

In the figures, Pl. I, Figs. A-I, are shown a series of stages illustrating characters of segmentation. The drawings* were made from the living egg. It should be noted that the egg capsule, when opened from either end, shows the egg with the animal pole uppermost. The egg itself measures between 4 and 5 cm. in diameter: it is of semi-fluid consistency, and is surrounded by a dense glairy albumen, which in turn in its outermost layer is attached to the egg capsule. The albumen is tenacious: it will flow over the rim of the opened capsule, and if the escaping mass is not promptly separated, it is apt to draw with it the albumen immediately surrounding the egg, and will thus destroy the spherical contour of the yolk. Mention might also be made of a delicate whitish membrane which surrounds the egg within the mass of albumen, reminding one, for example, of the vitellina of Necturus. The rupture of this delicate inner membrane is apt to disturb the contour of the egg. Removal of the end of the egg capsule together with the attached albumen, causes a flattening of the egg at the animal pole, more or less pronounced depending upon the amount of the albumen removed. It is exceedingly difficult to remove the egg from the capsule without rupturing it, although in several cases I have succeeded in doing so: it sinks flatly, very much as the yolk of a hen's egg. Whenever successfully removed it has shortly ruptured of its own weight. In examining the cleavage lines it has accordingly been found best to allow the egg to remain in the opened capsule. A view of the side and vegetal pole can then be had by rotating the egg by means of curved needles thrust into the adjacent albumen.

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* I am indebted to Messrs. N. Yatsu and I. Kuabara for their kindness in preparing them.

In Fig. A., is shown an early stage. The egg was collected at the time of deposition. There are few blastomeres and the radial pattern of the marginal furrows is well marked. The germinal disc is seen at the top of the figure. A somewhat similar stage is shown, Fig. B., from the region near the vegetal pole. The germ disc is situated on the side away from the observer: its position, however, is indicated by dots, as if shown through the egg. The present specimen is an interesting one since it shows one of the few cases in which I was able to satisfy myself that the furrows could sometimes be traced well down toward the vegetal pole, in fact that one or two of them actually traverse it. This stage well illustrates the flattening of the groove-like ends of the cleavage lines. A later stage, Fig. C., shows a greater number of meridional and marginal cleavages. The germinal disc appears at the lower left hand side of the figure In Fig. D., a lateral view is given of an egg somewhat similar to the foregoing. The specimen is noteworthy in as much as the radial (meridional) lines pass quite uniformly as far as the region of the equator of the egg. More irregular in this regard is the egg shown in Fig. E. In this several of the lines pass further towards the vegetal pole than their fellows. In the egg shown in Fig. F., the meridional furrows pass still further toward the vegetal pole.

In Fig. G. is pictured the animal pole of an egg somewhat finely subdivided by cleavage lines. In Fig. H., a stage of gastrulation, the cleavage lines are interestingly shown through the transparent edge of the blastoderm. From the radial arrangement of these furrows it can be inferred that the embryo is travelling tail foremost over the animal pole of the egg. And in a still later gastrula, Fig. I., it will be noted that a number of large blastomeres are seen conspicuously through the constricting blastopore. From the radiating lines which thus appear, we can reasonably infer that the embryo has travelled still further backward.

In order to give a more convincing idea of the appearance of the above described cleavage lines, I have inserted, Figs. J-O, a few photographs of the living egg. These show the lines clearly enough, although, technically speaking, the pictures are faulty, for they were

necessarily taken through an irregularly refracting mass of albumen. In the first of these photographs, J, an early stage, the radial arrangement of the marginal furrows is clearly marked. In K, the egg has been rotated so that the flattened groove-like ends of the furrows can be seen from the region of the vegetal pole. The remaining figures picture the egg in the region of the animal pole, and indicate various degrees of its subdivision into blastomeres.

If we accept the foregoing observations as evidence of holoblastic reminiscence, the egg of Cestracion is evidently of considerable value in comparison with the cleavage characters of other ichthyopsids. We can thus conclude that the great size of the eggs of other sharks was attained before total cleavage became lost; and that accordingly the yolk region of such eggs is directly, not indirectly, or partially, homologous with the lower pole cells in other ichthyopsids. Cestracion also indicates that the change in the position of the germ disc occurred before holoblastic cleavage was given up, and we have with it the suggestion that it was from some new or modified physiological cause that a distinction came to arise between the germ disc region and the region of the upper pole. In such a functional change may have arisen an efficient cause for the disappearance of the holoblastic type of cleavage, which up to that time had continued to develop on ancient lines, *pari passu* with the differentiation of the lighter and heavier deutoplasmic elements of the egg.

Marine Laboratory of the Imperial University of Tokyō,

Misaki, June 8. 1901.

Postscriptum. Misaki, July 1.

I have recently taken several eggs (early blastula) from the oviduct of Cestracion. And there can now be little doubt that the lines represent cleavages. In one specimen the entire region of the living germ disc was successfully removed and viewed as a transparent object, and one could then detect cellular outlines bridging the space between the germ disc and the yolk furrows.

B. D.

On the Relation of the Metameric Segmentation of Mesoblast in Petromyzon to that in Amphioxus and the Higher Craniota.

(Preliminary)

BY

S. Hatta.

It has been very well known for a long time that the mesoblast in all Vertebrata undergoes the metameric segmentation only in its dorsal part adjacent to the chorda and neural canal, while the ventral part remains unsegmented. Further, efforts have been made to bring the fact in harmony with the corresponding process observable in *Amphioxus*. Setting aside innumerable literature on the subject, I will cite here O. HERTWIG's [1] formulation of the fact, which runs as follows: "Ähnliche Vorgänge (as in *Amphioxus*) vollziehen sich in etwas abgeänderter Weise bei den übrigen Wirbelthieren" (p. 139). How far the mode is modified, we see in the following lines given by the same author [2]: "Während nun beim Amphioxus der Process der Segmentirung sich auf das gesammte mittlere Keimblatt ausgedehnt, ergreift er bei den Amphibien und ebenso bei allen übrigen Wirbelthieren nur den Theil, welcher an Chorda und Nervenrhor angrenzt, lässt dagegen die Seitenplatten unberührt" (p. 140). It is easily conceivable that there is a gap between the case in the Craniota and that in *Amphioxus*, although there would be no difficulty in accepting that the process in both cases is analogous, and the parts thus formed are homologous with each other. But the attempt to derive one type from the other is, so far I am aware, has not been supported with any positive evidence for it

1) Lehrbuch der Entwicklungsgeschichte der Menschen und der Wirbelthiere. 3. Auflage, 1890.

2) Loc. cit.

The obscurity of the interrelation between the two cases is doubtless caused by the modified mode of formation of the mesoblast in the higher Craniota. If such be the case, there is some excuse in describing the precise mode of the metameric segmentation of mesoblast in *Petromyzon*, which forms the subject of present communication.

As discovered by v. KUPFFER [1] and confirmed by myself [2] as far back as ten years ago, the mesoblast in *Petromyzon* is brought about, in the anterior region, by a simple folding of the entoblast, just as in *Amphioxus*. The question above referred to must be, therefore, decided by a careful observation of the metameric segmentation in this part of the mesoblast. The harmony between the two cases, if such truly exist, ought to be seen here.

In the course of differentiation of the mesoblast in the head fold of *Petromyzon*, I have found great harmony between the case in *Potromyzon* and that in *Amphioxus* ; I will enumerate it in the following lines :—

1) Before the metameric segmentation, the mesoblast is a sack of the cylindrical epithelium, which is, on a cross-section, of a triangular shape and fills up the space on either side of the chorda and neural cord, bordered upon laterally by the epiblast and ventrally by the roof of the enteric canal.

2) The metameric segmentation of the mesoblast is not confined to the proximal part of the layer adjacent to the axial organs, but goes through the whole substance of it.

3) In a mesoblastic somite thus formed, the proximal (dorsal) and distal (ventral) portions are distinguished : they constitute respectively the scleromyotome and a part which loses later the segmental character and, by the subsequent growth of which the non-segmented lateral plate is brought about.

4) The scleromyotome is converted, having been cut off from the rest of the mesoblast, into a polyhedral case which is interposed between

1) V. KUPFFER, Die Entwickelung von Petromyzon Planeri: Arch. f. mikrosk. Anat., Bd. XXXV, p. 501, 1890.

2) S. HATTA, On the Formation of the Germinal Layers in Petromyzon: Journ. Coll. Sc.Imp. Univ., Tokyo, vol. v. 1891.

the epiblast, the chorda, the neural cord, the distal part of the mesoblat, and the roof of the enteric canal.

5) By stages, the shape of the scleromyotome is again converted into an elongated triangle. The greater part of its inner long limb which touches the axial organs, is transformed into the body-muscle, while the outer long limb along the epiblast is flattend to form the cutis layer. Finally the base of the triangle, which rests on the distal part of the mesoblast and the roof of the enteric canal, is likewise thinned out and evaginates, pushing its way between the muscle-layer and the axial organs ; this is the sclerotome.

In the dorsal region, the process of segmentation is essentially the same as in the head-fold. The process goes on through the whole breadth of the layer before the separation of the scleromyotome from the rest of the mesoblast. Here the circumstance is more or less altered by the differentiation of the Anlage of the pronephros which follows immediately the segmentation. But this does not disturbe the parallel, because the morphological equivalent of this section of the somite is found in the head-fold, which does not develop into the pronephros, but after having lost its segmental character, takes part in the formation of the non-segmented lateral plates.

The facts mentioned above agree with those in *Amphioxus* obtained by HATSCHEK [1]) so far as concerns the stage up to the end of the metameric segmentation and the fate of the scleromyotome. The parallel of the further growth of the ventral half of the somite (the Seitenplatte of HATSCHEK), which takes place immediately after this stage, has not hitherto been demonstrated in *Amphioxus*. But there is little room for doubt that the Seitenplatte grows ventrally (distally) after the obliteration of the coelomic discepments and before the foundation of the subintestinal vein ; for in *Petromyzon*, this vein appears in much later stages.

1) B. HATSCHEK, Studien über Entwickelung des Amphioxus: Arb. Zool. Instit, Wien, vol. iv, 1881.

As I have already mentioned[1], it is a fixed fact that the line of the separation of the scleromyotome (the Urwirbel of HATSCHEK) from the rest of the mesoblast agrees with each other in both cases : it divides the segmented part of the mesoblast into the dorsal (Urwirbel) and the ventral (Seitenplatten) halves. The Urwirbel of *Amphioxus* undergoes exactly the same fate as the scleromyotome of *Petromyzon*. In *Petromyzon*, the ventral half forms, as above stated, the Anlage of pronephros and the coelomic projection ; this point has not yet been made clear in *Amphioxus*. But the reasonable suggestion of BOVERI[2] makes it intelligible that this section of the mesoblast should give rise to the formation of the Nierencanälchen, that is, the excretory organ of segmental character.

The results arrived at in *Petromyzon* differ from those in the higher Craniota concerning the extent, to which the process of the segmentation takes place. In the Craniota the segmentation is confined to a small proximal part, while in *Petromyzon* the whole breadth of the layer undergoes the process. But this difference is, I think, easily explained by a more precise examination of the stage, in which the segmentation takes place. In the higher Craniota, this process comes to an end only in later stages when the mesoblast, i. e. lateral plate, has grown considerably. While the segmentation is going on in the proximal part, the lateral plate itself grows distally. And thus a phenemenon which leads one to think of the process confined exclusively to a small proximal part alone comes into view. The segmented and non-segmented parts uudergo essentially the same fate as in *Petromyzon*.

The differentiation of the mesoblast in *Petromyzon* holds, in this respect, very important position in the morphology of the Chordata. In earlier stages, it is exactly parallel with that in *Amphioxus*, and in later stages, it shows the feature seen in the higher Craniota. We can thus observe in one and the same animal, *Petromyzon*, the stages, through which the primitive state of the mesoblast in *Amphioxus* has developed

1) S. HATTA, Contrib. Morphol. Cyclost. ii.: Journ. Coll. Sc. Imp. Univ., Tokyo, vol. xiii. 1900.

2) T. BOVERI, Die Nierencanälchen des Amphioxus: Zool. Jahrb. vol. v. 1892.

into the condition in the higher Craniota. These facts can have no other significance than as a connecting link between Amphioxus and the the Craniata, to which reference has already been made at the beginning of the article.

My obligations are due to PROFESSOR MITSUKURI and PROFESSOR WATASE for their kindness looking through the manuscripts.

Biological Laboratory, the Gakushuin, Tokyo.

May 29th, 1901.

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CONTENTS:

Über das Blutgefässsystem der Hirudineen.

Vorläufige Mitteilung

Von

Asajiro Oka, Tokyo.

Im Laufe einer ausführlichen Untersuchung über die Anatomie der Hirudineen, die schon vor einigen Jahren begonnen wurde, bin ich allmählig zur Überzeugung gekommen, dass die Auffassungen in Betreff des Blutgefässsystems dieser Tiere, wie sie gewöhnlich in Lehrbüchern angegeben sind, dem wirklichen Sachverhalte durchaus nicht entsprechen. Ich erlaube mir im Folgenden einige Ergebnisse meines Studiums, welche mich zu dem obigen Schluss geführt haben, schon jetzt kurz mitzuteilen, da mir dieselben für das richtige Verständniss der Organisation der betreffenden Tiergruppe von fundamentaler Bedeutung zu sein scheinen.

Die vorliegenden Angaben über die Bluträume der Hirudineen verdanken wir hauptsächlich Leydig[1], de Quatrefages[2], Whitman[3], und Bourne[4]. Nach diesen Forschern bestehen die blutführenden Räume bei diesen Würmern überall aus zwei ganz verschiedenen Systemen, d.h. einem eigentlichen mit einer deutlichen Wandung versehenen Blutgefasssystem und einen jeder Wandung entbehrenden Lakunensystem; die beiden Systeme kommen jedoch in den verschiedenen Abteilungen der Hirudineen so verschiedentlich zur Ausbildung, dass es unmöglich ist, davon ein für die ganze Gruppe geltendes Schema zu konstruiren. So besitzen z. B. die Gnathobdelliden zwei Seitengefässe.

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1) Leydig, Zur Anatomie von Piscicola geometrica mit theilweiser Vergleichung anderer einheimischer Hirudineen. Zeitschr. f. wiss. Zool. Bd. I. 1849.

2) Quatrefages, Histoire naturelle des Annelés marins et d'eau douce. 1865.

3) Whitman, the Embryology of Clepsine. Quart. Journ. of micr. Sc. XVIII. 1878.

4) Bourne, Contributions to the Anatomy of the Hirudinea. Quart. Journ. of micr. Sc. XXIV. 1884.

welcher die Glossiphoniden entbehren; dagegen sind die letzteren mit einem Rücken- und einem Bauchgefäss versehen, die den ersteren abgehen. Bourne, welcher das Blutgefässsystem aller Hirudineen von einem gemeinsamen Grundtypus abzuleiten versuchte, hielt die Organisationsverhältnisse, wie wir sie bei *Pontobdella* finden, für die ursprünglichen, indem er glaubte, dass bei dieser Gattung sämmtliche Längsstämme sowohl des Blutgefässsystems wie des Lakunensystems, die überhaupt bei Hirudineen vorkommen, gleichzeitig existirten. Hier soll nämlich nach diesem Autor, das Blutgefässsystem aus vier Längsstämmen, einem dorsalen, einem ventralen und zwei lateralen, bestehen, welche je in einem entsprechenden Längsstamm des Lakunensystems eingeschlossen seien. Von diesen vier Längsgefässen entwickelten sich bei den Gnathobdelliden nur die seitlichen, bei den Glossiphoniden dagegen nur die medianen. Ähnlicherweise wären bei den Glossiphoniden alle vier Längsstämme des Lakunensystems wohl entwickelt, während bei den Gnathobdelliden nur die medianen, bei der Gattung *Herpobdella* sogar der einzige ventrale, zurückblieben. Bei allen diesen Formen sollen übrigens beide Systeme von Bluträumen in offener Kommunication stehen, so dass in beiden ein und dieselbe Flüssigkeit zirkulirt. Was die morphologische Bedeutung der Gefässe und Lakunen betrifft, so sagt Bourne „as De Quatrefages pointed out, the former (Gefässsystem) seems to represent the closed vascular system of Chaetopoda, while the latter (Lakunensystem) is probably coelom, whether in the state of new formation, or gradually becoming occuluded, i.e. in a state of degeneration."

Wie aus diesem Überblick hervorgeht, bieten die Hirudineen nach unserer gegenwärtigen Auffassungsweise im Bau des Blutgefässsystems eine ganze Reihe von Eigenthümlichkeiten, welche uns zu rechtfertigen scheinen, diese Würmer als eine höchst sonderbare Abteilung des Annulatenstammes zu betrachten; denn ein Gefässsystem, von dessen vier Längsstämmen bald nur die medianen, bald nur die lateralen sich entwickeln, welches ferner mit einer stark reduzirten, gefässartig aussehenden Leibeshöhle in offener Verbindung steht, findet man sonst wohl nirgends im Thierreich. Wie auffallend diese Organisations-

verhältnisse auch zu sein scheinen, so begegnen wir doch in meisten neueren Lehrbüchern lauter Angaben, die im Allgemeinen mit der obigen übereinstimmen. So giebt z. B. Hertwig [1] an, "dass ihre Leibeshöhle rückgebildet ist, indem sie durch Parenchymwucherung eingeengt und zu Längscanälen, die mit dem Blutgefässsystem in Verbindung traten, umgewandelt wurde." In ähnlicher Weise sagt Lang [2] "Beide Systeme von Hohlräumen (Blutgefässe und Leibeshöhle) stehen mit einander derart in Verbindung, dass es schwer fällt, sie von einander zu trennen." Selenka giebt in seinem vorzüglichen Taschenbuch an, "Die reduzirte Leibeshöhle kommunizirt mit dem wohlentwickelten Blutgefässsystem."

Dass das Blutgefässsystem der Hirudineen allgemein mit der Leibeshöhle in Kommunikation stehe, erschien mir um so sonderbarer, als durch die Untersuchungen von mir [3] und von Johansson [4] der Nachweis geliefert wurde, dass bei einzelnen Gattungen das Blutgefässsystem vollkommen geschlossen, also mit der Leibeshöhle in keiner Weise verbunden ist. Ich habe nämlich gezeigt, dass bei den Gattungen *Glossiphonia*, *Helobdella*, und *Hemiclepsis* das Blutgefässsystem aus einem dorsalen und einem ventralen Längsstamm besteht, die an beiden Enden durch eine bestimmte Anzahl von Schlinggefässen mit einander kommuniziren, jedoch an keiner Stelle direkt in die Leibeshöhle ausmünden; und dasselbe bewies Johansson für die Ichthyobdelliden Schwedens. Indem wir beide aber unsere Studien je an eine kleine Abteilung der Hirudineen beschränkten, waren wir damals nicht im Stande über das Blutgefässsystem der ganzen Gruppe Etwas bestimmtes vorzubringen. Jetzt vermag ich, nach einer sorgfältigen vergleichend-anatomischen Untersuchung aller Hauptabteilungen der Hirudineen, den Gesammtbild der Bluträume dieser Tiere zu entwerfen, welcher eine Homologisirung verschiedener Abschnitte derselben zu ermöglichen scheint.

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1) Hertwig, Lehrbuch der Zoologie.

2) Lang, Lehrbuch der Vergleichenden Anatomie.

3) Oka, Beiträge zur Anatomie der Clepsine Zeitschr. f. wiss. Zool. Bd. LVIII. 1894.

4) Johansson, Bidrag till kännedomen om Sveriges Ichthyobdellider Akad. Afh. 1896

Meine Beobachtungen beziehen sich auf die folgenden Genera:

Glossiphonidae,—*Glossiphonia, Helobdella, Hemiclepsis.*

Ichthyobdellidae, -*Ozobranchus, Pontobdella, Callobdella, Piscicola,*

Gnathobdellidae.—*Hirudo, Haemadipsa.*

Herpobdellidae.—*Herpobdella, Orobdella, Mimobdella.*

Von diesen zwölf Gattungen weisen diejenige, die zu derselben Familie gehören, in Betreff des Verhaltens der Bluträume grosse Übereinstimmung auf, so dass sie zusammen behandet werden können.

Glossiphonidae. Was das Blutgefässsystem von *Glossiphonia, Helobdella,* und *Hemiclepsis* betrifft, so habe ich es in einer früheren Abhandlung [1] ausführlich beschrieben, so dass ich hier darüber nur ganz kuzz mitzuteilen brauche. Bei diesen Gattungen besteht das Blutgefässsystem aus einem dorsalen und einem ventralen Längsgefäss, die an beiden Körperenden je durch einige Gefässschlingen mit einander in Verbindung stehen. Die wohl entwickelte Leibeshöhle ist in drei Längsstämme, zwei Seiten- und eine Medianlakune, zertheilt, welche letztere wieder durch den Darmkanal mit seinen Ausbuchtungen in die dorsale, die ventrale, und die Zwischenlakune gesondert werden können. Die Seitenlacune trennt sich von der Medianlakune hauptsächlich durch die Reihe von dorso-ventralen Muskeln, welche jedoch segmental durch die Kommunikationslakune unterbrochen ist. Wie oben bemerkt steht das Blutgefässsystem mit der Leibeshöhle nirgends in Kommunikation.

Die Fig. 1 stellt einen Querschmitt durch den mittleren Körperteil einer *Hemiclepsis* (*tesselleta*) dar. Die grosse Medianlakune ist hier durch den Darm (D), den Hoden (T), und die dorsoventralen Muskeln in mehrere Abschnitte (dl, vl, zl, zl) geteilt. Die Seitenlakune (sl) kommunizirt mit der medianen durch einen kurzen Querkanal (cl). Die Hypodermallakunen, welche aus den Seitenlakunen entstammen und sich dicht unterhalb der Epidermis ausbreiten, sind in der Figur nicht

1) a. a. O., S. 108.

repräsentirt. Vom Blutgefässsystem begegnen wir das Dorsal-(dg) und das Ventralgefäss (vg); beide liegen frei in der dorsalen (dl), resp. ventralen Abteilung (vl) der Medianlakune.

Ichthyobdellidae. Die blutführenden Räume der Ichthyobdelliden bieten in

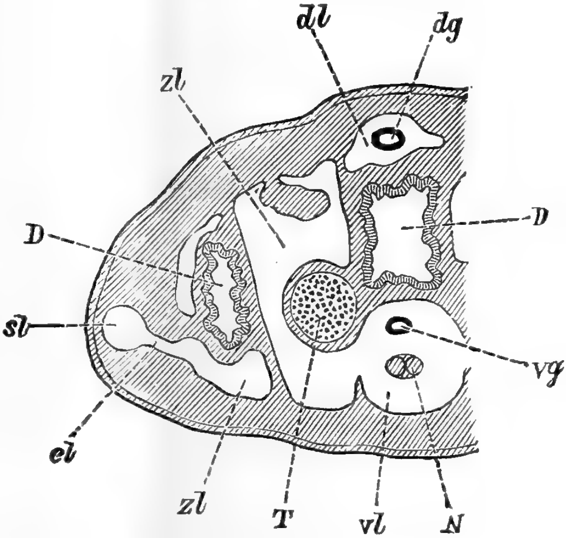

Fig. 1.

sofern grosse Interesse, dass sie gewissermassen ein Übergangs stadium zwischen Glossiphoniden und Gnathobdelliden darstellen Bei allen vier Gattungen, die ich untersucht habe, verhalten sich die eigentlichen Blutgefässe genau wie bei den Glossiphoniden. Hier wie dort finden wir ein Dorsal- und ein Ventralgefäss, welche an beiden Körperextremitäten durch seitliche Aeste mit einander in Verbindung stehen. Wie Johansson für die Ichthyobdelliden Schwedens ausdrücklich betont hat, [1] ist das Blutgefässsystem vollkommen geschlossen; eine offene Kommunikation zwischen den Blutgefässen und der Leibeshöhle findet nirgends statt. So weit stimmen die Ichthyobdelliden mit den Glossiphoniden überein. Ein merkwürdiger Unterschied aber findet sich zwischen diesen zwei Familien in der Beschaffenheit der Leibeshöhle; er besteht nämlich darin, dass bei den Ichthyobdelliden ein Teil des Lakunensystems, und zwar die Seitenlakunen, mit

1) a. a. O. S. 87 "Lika skarpt vill jag ocksa° beträffande de af mig undersögta Ichthyobdellidsläktena betona, att blodkärlsystement är fullkomligt slutet och ingenstädes kommunicerar med kroppshälesystemet,..............."

muskulöser Wandung versehen und dadurch kontraktil und täuschend gefässartig geworden ist. Es eind dies die sogen. Seitengefässe der Ichthyobdelliden, die man bisher mit Unrecht zum Gefässsystem gehören liess. Auch ich habe sie anfänglich als wahre Blutgefässe aufgefasst, aber eine genaue Untersuchung über ihren Verlauf und ihre Verhältnis mit den übrigen Abteilungen des Lakunensystems überzeugte mich bald von ihrer Lakunennatur.

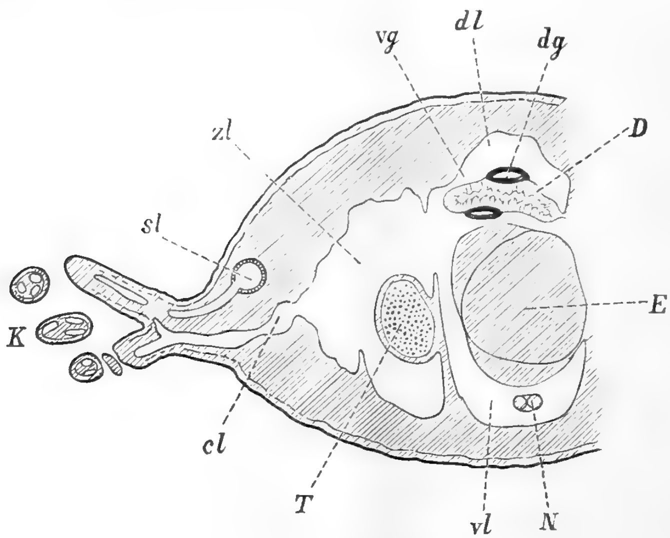

Fig. 2.

Fig. 2 repräsentirt einen Querschnitt der Kiemenregion eines *Ozobranchus* (*branchiatus*). Die wohl entwickelte Medianlakune ist durch den Darm (D), den Hoden (T), und die dorsoventralen Muskeln in verschiedene Abschnitte (dl, vl, zl) geteilt, gerade wie es bei *Hemiclepsis* (Fig. 1) der Fall war. Die mit muskulöser Wandung ausgestattete, gefässartige Seitenlakune (sl) steht mit der Medianlakune durch Vermittelung der feinen Kanäle des Kiemenapparates nur indirekt in Verbindung. Dass die letzteren keine Blutgefässe, sondern nur Teile der Leibeshöhle sind, habe ich schon an anderem Orte hervorgehoben.[1] Von dem eigentlichen Blutgefässsystem sind in der Figur nur die beiden Längsgefässstämme (dg, vg) zu sehen, welche an der dorsalen, resp. ventralen

1) Oka, Description d'une espèce d'Ozobranchus, Zool. Mag. VII. 1895. S.5.

Wand des Darmes angehefted erscheinen.

Die obige Beschreibung passt für die drei anderen Gattungen ebenso gut wie für *Ozobranchus*. Nur hat man dabei statt der feinen Canäle des Kiemenapparates ein kontraktiles Seitenbläschen zu setzen. Die paarig angebrachten Seitenbläschen von *Pontobdella, Callobdella,* und *Piscicola* kommunizieren durch Verbindungskanäle einerseits mit der gefässartigen Seitenlakune, anderseits mit der weiten Medianlakune und stellen somit bloss einen Teil der Leibeshöhle dar.

Der Umstand, dass ein Teil der Leibeshöhle gefässartig und kontraktil geworden ist, ist ohne Zweifel der Grund, warum die Bluträume der Hirudineen, trotz zahlreichen Untersuchungen, bis jetzt in so unrichtiger Weise aufgefasst worden sind. Bourne, welcher die Anwesenheit einer besonderen muskulösen Wandung als ein Kennzeichen der Gefässnatur eines Hohlraums in Anspruch nahm, lässt die Seitenlakunen von *Pontobdella* natürlich zum Blutgefässsystem gehören, und so kam zu dem Gedanke, dass das Blutgefässsystem der Hirudineen ursprünglich aus vier Längsstämmen sich zusamensetzten. Hätte er den Bau von diesem Fischegel statt an vereinzelte Schnitte, sondern an vollkommene Schnittserien untersucht, wie ich es gethan habe, so könnte er unmöglich die Seitenkanäle als wahre Gefässe auffassen. Sie laufen beiderseitig dem Körperrand entlang, vereinigen sich am vorderen und hinteren Enden mit einander, am Kopfende auch mit der kanalartigen Fortsetzung der Medianlakune. In mittlerer Region des Körpers stehen sie mit der Medianlakune durch die paarige Querlakunen in Verbindung, welche bei den mit besonderen Athmungseinrichtungen ausgestatteten Formen einen Umweg durch die letzteren machen. Sie stehen, ferner, mit dem eigentlichen Blutgefässsystem an keiner Stelle in Kommunication. Kurz, die Seitenkanäle der Ichthyobdelliden stimmen mit den Seitenlakunen der Glossiphoniden in allen wesentlichen Beziehungen, bis auf die muskulöse Wandung, so vollkommen überein, dass man die beiden Gebilde unbedingt als identisch betrachen muss.

Die Behauptung Bourne's,[1] dass bei *Pontobdella* die kontraktilen Seitenkanäle von einem "lateral sinus" ähnlich umschlossen sind, wie das Dorsal- und Ventralgefäss vom dorsalen resp. ventralen Lakune, scheint nicht auf direkte Beobachtung, sondern vielmehr auf seine theoretische Betrachtung zu beruhen: denn er giebt selbst zu, dass "this is never really developed as a sinus around the lateral vessel (Seitenlakune), but there is looseness about the connective tissue outside the muscular wall of the vessel." Da sein "lateral vessel" nichts anders ist, als die Seitenlakune, so kann ein besonderes "lateral sinus" ausserhalb dieses nicht existiren. Die schematische Figur vom Querschnitt von *Pontobdella*, welche Parker and Haswell, Perrier, und Sedgwick aus Bourne's Arbeit entlehnen, repräsentirt demgemäss einen Zustand, welcher in Wirklichkeit nie vorkommt.

Gnathobdellidae. Bei *Hirudo* und *Haemadipsa* bilden die sämmtlichen blutführenden Räume des Körpers ein einziges, zusammenhängendes System, durch welches ein und dieselbe Flüssigkeit zirkulirt. Dieses System besteht hauptsächlich aus vier Längstämmen, zwei sogen. Seitengefässen und zwei medianen Längskanälen, die oft auch Dorsal- und Ventralgefäss genannt werden, jedoch offenbar nichts anders darstellen, als durch Parenchymwucherung eingeengte Leibeshöhle. Wie sich diese vier Längsstämme mit einander verbinden, ist schon durch zahlreiche, theils sehr minutiöse Untersuchungen[2] zur Genüge bekannt. Segdwick[3] vermuthet, dass auch bei den Gnathobdelliden ein geschlossenes Blutgefässsystem nebst der reduzirten Leibeshöhle vorhanden sei, aber diese Annahme ist neulich durch die genaue Untersuchung von Goodrich[4] endgültig beseitigt worden. Von dem wahren Blutgefässsystem, wie wir es bei den Glossiphoniden und Ichthyobdelliden vor uns haben, findet man bei diesen Gattungen keine Spur.

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1) a. a. O. S.

2) z. B. Vogt und Yung, Praktische Vergleichende Anatomie.

3) Sedgwick, Students Text-Book of Zoology.

4) Goodrich, On the Communication between the Coelom and the Vascular system in the Leech. Quart. Journ. micr. sc. Vol. 42. 1899.

Ein Blick auf die Fig. 3, welche einen Querschnitt durch den mittleren Körperteil eines japanischen medicinischen Blutegels (*Hirudo nipponia*) darstellt, wird schon genügen die oben angeführten Verhältnisse klarzustellen. Das enge Dorsallakune (dl) befindet sich an der Rückenseite des Darmes (D); an der Bauchseite desselben beobachtet man die etwas weitere Ventrallakune (vl) mit darin eingeschlossenen Bauchmark (N). Die sogen Seitengefässe (sl) kommunizieren mit den medianen Lakunenstämmen nur durch feine Kanäle. Weder das Dorsalnoch das Ventralgefäss ist hier zu beobachten.

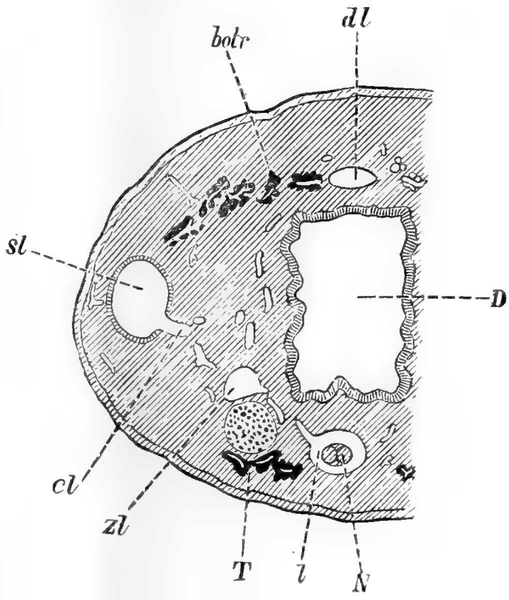

Fig. 3.

Herpobdellidae. Auch die Egel dieser Familie sind in Hinsicht auf die Bluträume schon genügend untersucht worden; wir haben in der Literatur Abbildungen,[1] die den Verlauf und die Anastomose der Hauptkanäle sehr schön wiedergeben, so dass ich es für unnötig halte, sie hier zu beschreiben In allgemeinen Zügen näheren sich die Gattungen *Herpobdella*, *Orobdella*, und *Mimobdella*, in der Beschaffenheit dieser Räume, sehr an *Hirudo*.

Fig. 4, einen Querschnitt von *Herpobdella* (*octoculata*) darstellend, zeigt, wie stark die Leibeshöhle auch bei dieser Gattung reduzirt ist. Sogar die Dorsallakune, die wir bei *Hirudo* finden, ist hier verschwunden, so dass im Ganzen nur drei Längskanäle (sl. vl) vorhanden sind. Bei *Orbdella* und *Mimobdella* existirt noch eine schmale Dorsallakune.

1) Jaquet, Recherches sur le systeme vasculaire des Annelides. Mitth. a. d. Zool. Stat. zu Neapel. VI. 1886.

Wenn man nun die Fig. 3 und 4 mit der Fig. 2 vergleicht, so wird man sofort wahrnehmen, dass die sogen Seitengefässe von *Hirudo* und *Herpobdella* genau entsprechende Stelle einnimmt, wie die von Ichthyobdelliden; ihre Verbindungsweise mit anderen Bluträumen ist in beiden Fällen auch fast dieselbe. Sie sind in der That identische Gebilde. Wie ich das Seitengefäss von Ichthyobdelliden als Homologon der Seitenlakune von Glossiphoniden betrachte, so kann ich bei den Gnathobdelliden und Herpobdelliden auch nicht umhin, sie als solches anzusehen. Nach meiner Meinung bilden die sämmtlichen Bluträume des Gnathobdellidenkörpers eine stark reduzirte Leibeshöhle; von dem, was dem geschlossenen Blutgefässsystem der Chaetopoden entsprechen sollte, besitzen die Egel dieser Familie nichts. Was man bis jetzt als wahre Blutgefässe andeutete, stellt nichts anders dar, als gefässartig umgewandelte Teile der Leibeshöhle.

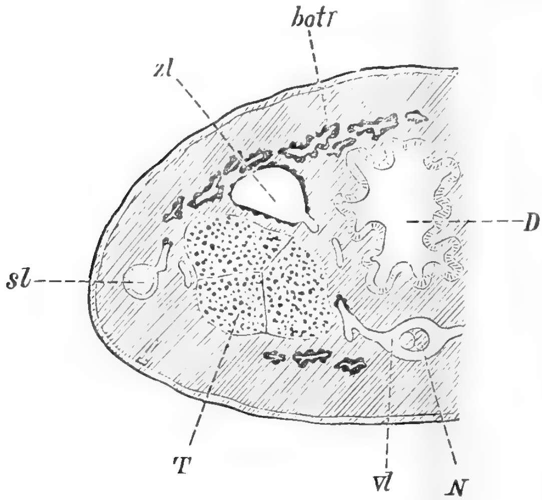

Fig. 4.

Dass man die Leibeshöhle gewisser Hirudineen mit dem wirklichen Blutgefäss verwechselt hat, rührt hauptsächlich daher, dass man beim Untersuchen des Vascularsystems vielfach den medicinischen Blutegel als Typus nahm, und durch Injektionen den Verlauf einzelner Kanäle zu verfolgen sich bemühte. Durch solches Verfahren gewinnt man freilich à priori den Eindruck, als wären die Kanäle Blutgefässe.

Aus den obigen Erörterungen wird man leicht ersehen, dass bei den Hirudineen, unter dem Namen Blutgefäss zwei Dinge von ganz ver-

schiedener Natur umfasst worden sind; einmal, das eigentliche Blutgefäss von Glossiphoniden und Ichthyobdelliden, und dann, die gefässartige Seitenlakune von Ichthyobdelliden, Gnathobdelliden, und Herpobdelliden. Sogar die Dorsal- und die Ventrallakune wurden manchmal als Blutgefässe aufgefasst. Es ist einleuchtend, dass so lange solche Verwirrung herrscht, von einer richtigen Verständnis der Organisation der Hirudineen keine Rede sein kann.

Kurz zusammengefasst lässt sich meine diesbezügliche Meinung, wie folgt, ausdrücken :

1. Eine Leibeshöhle kommt bei allen Hirudineen vor; sie tritt bei den Glossiphoniden und Ichthyobdelliden viel deutlicher hervor, wie bei den Gnathobdelliden und Herpobdelliden. Bei diesen ist sie durch Wucherung des Bindegewebes etc. sehr eingegengt.

2. Ein eigentliches Blutgefässsystem besitzen nur die Glossiphoniden und Ichthyobdelliden. Dasselbe ist vollkommen geschlossen und ist im Allgemeinen wie das Blutgefässsystem der Chaetopoden gebaut. Was man bei Gnathobdelliden und Herpobdelliden Blutgefässe nannte, ist bloss gefässartige Teile der Leibeshöhle.

3. Die Ichthyobdelliden stellen gewissermassen ein Uebergangsstadium zwischen den Glossiphoniden und den Gnathobdelliden dar, indem bei ihnen sowohl das wirkliche Blutgefässsystem, als die gefässartige Seitenkanäle vorhanden sind.

Am Schluss möchte ich noch einige Worte über die Verwandschaftsbeziehungen von Hirudineen mit anderen Tieren hinzufügen. Wie aus den oben angeführten Gedanken ersichtlich, fasse ich die Hirudineen als coelomate Gliederwürmer auf, die den Chaetopoden, und zwar den Oligochaeten, mit welchen sie auch in der Zwitternatur der Geschlechtsorgane übereinstimmen, am nächsten stehen. Unter den Hirudineen stehen wieder die Glossiphoniden den Regenwürmern am nächsten; dabei stellen *Branchiobdella* und *Acanthobdella* die Uebergangsformen zwisehen den beiden Gruppen dar. Die nebenstehende, aus Kowalevesky's Arbeit entlehnte Figur, welche einen Querschnitt durch *Acanthobdella* repräsentirt, zeigt zur Genüge, wie durch diese Tierform die

Glossiphoniden sich an Oligochaeten knüpfen lassen. Auf der anderen Seite, nun, bilden die Ichthyobdelliden eine Zwischenform, welche die Glossiphoniden mit den Gnathobdelliden verbindet; und so haben wir hier gleichsam eine Kette von Tierformen, die mit den Regenwürmern anfängt, und mit dem medicinischen Blutegel und *Herpobdella* endigt. Angesichts solcher Thatsachen leuchtet es von selbst ein, dass man Unrecht hat, die Hirudineen als eine besondere Unterclasse der Anneliden, oder gar als gegliederte Platt würmer zu betrachten.

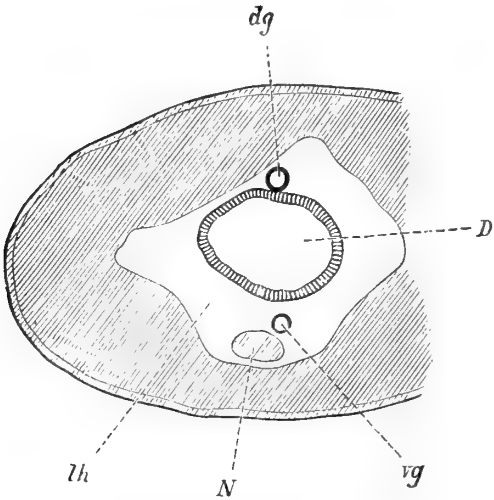

Fig. 5.

Tokyo, d. 15. Oktober, 1901.

On the Habits of the Japanese *Lingula*.*

BY

Naohidé Yatsu, *Rigakushi.*

The present short notes are published as a supplement to the œcological observations of the previous writers, such as MORSE, SEMPER, and FRANÇOIS. But before entering into the habits I shall touch upon the distribution and the specific characters of the Japanese *Lingula*.

From Japanese waters five species of *Lingula* have been described. They have however, been declared by DAVIDSON to be varieties of one and the same species (LISCHKE '69 p. 115). Whether this view is a correct one I cannot at present determine, since as yet I have not had the opportunity of examining materials from various localities in Japan. In the museum of the Zoological Institute there are specimens from Misaki, Hyakkan-zeki (Kyushū), and the islands of Bizen. Of these localities the second yields very large specimens and those of slightly different features from those collected at any other localities. At any rate all the specimens I have examined tally with *Lingula anatina* BRUG.

BLOCHMANN ('00. p. 94-95) enumerates several distinguishing characteristics of *Lingula anatina* BRUG from *Lingula murphiana* KING. Of these only the mode of branching of the pallial sinus seems to be a reliable criterion, all others being mere individual differences. In the specimens examined by me, the peduncle, for exmple, in some individuals terminates in an ampulla, while in others from one and the same locality it ends in solid attenuated cuticle. Some gape a little in the posterior part of the shell, while in others the shells are closed firmly all around the margins. Proportions of length, breadth and

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* This formed a part of my graduating thesis, but, as it has less connection with my embryological studies, I have thought it best to make it a separate paper.

thickness also vary a great deal; in some specimens the ratios agree with the figures of *L. anatina* given by BLOCHMANN, while in others with that of *L. murphiana*. In all cases the ventral valve is a little thicker than the dorsal. The largest specimen I have examined is 45 mm. in length, 20 mm. in breadth and 10 mm. in thickness. Of the specimens from Misaki the largest measures 36.5 mm. in length and 16.5 mm. in breadth.

As far as I have been able to ascertain, *Lingula* occurs only along the coast of southern Japan, but in that part one may expect to find it in every suitable mud-flat. It is not found in deep water at all. In some localities it occurs in a great abundance. At Yanagawa, a village by the Ariake bay, Kyushū, *Lingula* is so plentiful that it is sold by the peck and forms an article of diet. In this region the whole animal is boiled and eaten. At Akura, Bizen, it is said that the peduncle only is used for food. In the vicinity of Misaki *Lingula* was formerly so abundant that we were frequently able to secure hundred or more specimens in a few hours' collecting, but of late years the number seems to have dwindled, owing no doubt to too great a demand made by naturalists on the supply. Still, in the neighborhood of the Station every mud flat yields specimens of *Lingula*. Such flats are exposed at low water and are covered at high water to the depth of 3–4 feet; of these the most favorable for *Lingula* are composed of sandy mud, blackened and ill-smelling from the decomposition of organic matter. Over such black mud a layer of somewhat dirty brown mud 2–3 mm. thick is found which is probably formed by the excrements of Annelids, *Lingula*, etc. The flats of clean sand, do not seem fit for the animal. Also the flats* in which *Lingula* lives are covered neither by Phanerogams nor by Algae, different from the habitat of *Lingula* at Numea, New Caledonia, as described by FRANÇOIS ('91) which is covered by marine Phanerogams.

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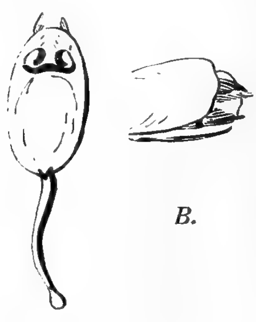
* Only one flat, where a few individuals live is covered, as an exception, by *Zostera nana*.

A visit to the collecting ground which is exposed at the time of low water shows at once that no trace of *Lingula* can be detected from the surface. The reason is probably as follows: the retreating tide disturbs mud, so that the entrance of burrow is stopped up and at this the animals retire deep in their burrows. This fact stands in opposition to the observations of FRANÇOIS and those of my friend Mr. NAMIYE who informs me that he was able at Bizen to find out the specimens by three holes on the surface of mud. In the localities examined by these observers, I think, the mud must be so hard or heavy that it is not easily disturbed by the tide. On digging, however, specimens are soon met with at a depth of about one foot. They show no sign of attachment to either rock or stone but it is so firmly fixed to the hard sandy mud that, when suddenly drawn out, the entire peduncle or its tip is apt to be torn off and remain in the mud. On pulling out the specimens we find that a bit of mud is usually encrusted at the tip of the peduncle, and in some cases the latter is attached to a fragment of bivalves. This stands in opposition to the description of DALL, which runs as follows: " the true Lingulas are almost always attached to a fixed rock or stone, while *Glottidia* attaches itself, if at all, only when adult, and usually to a very small pebble or bit of shell" (BEYER '86 p. 228). The tube-forming around the peduncle seldom takes place and is not so usual a phenomenon as described by MORSE. Nearer the shore are usually found younger individuals. It seems that the free-swimming life terminates in the shallows. The burrow is not always vertical; sometimes it is oblique or nearly horizontal, or sometimes it is bent in the middle, the lower limb being vertical. There are some cases in which two individuals are found in the same burrow, but this must be regarded as accidental; for in the first place their power of locomotion is very limited, and secondly as fertilization takes place in the open water it is of little advantage for them to dwell in pairs.

For the purpose of studying the œcology of *Lingula* I kept in the autumn of last year, a number of individuals of various sizes in

cylindrical specimen jars, in which the mud was so placed as to imitate as far as possible the natural conditions. I buried a specimen deep in the mud, touching the inner wall of the jar in order to observe how it makes its burrow. At first the water is forcibly gushed out of the central funnel formed of the mantle edge and the setae. By this the mud above the animal was gradually removed. By the above action coupled with the sliding lateral motion of the shell, the burrow was soon formed, whose walls were made smoth owing to the secretion of the gland-ridge (Drüsenwall) and to the up-and-down gliding of the valves. Seen from above the burrow gives a rhombic aspect a little larger than the section of the animal. *Lingula* can extrude itself above half of its shell length from the surface of the mud; when alarmed it would retire 5–30 cm. below the mud surface according to the size. At that time we can perceive how great the contractibility of the peduncle is. When the animals are dug out of its burrow the peduncle is of the minimum length. The peduncle, it should be noted, of our *Lingula* is comparatively short. In *Glottidia* according to MORSE, it reaches nine times the shell length. This difference in length of the peduncle can readily be noticed so early as the stage of 7-9 pairs of cirri.

Some Brachiopods can protrude their arm-apparatus out of the shell as observed by MORSE (79). According to him, such is the case in *Lingula*, (p. 257). On the contrary SEMPER ('64) states of the animal "dass Arme niemals zur Schale hervor gestreckt werden und sich niemals enrollen" (p. 424). To settle this point I placed a number of individuals in a glass vessel and looked at them carefully. At last I found that only the comb-like row of cirri of the largest whorl of the arm can be projected out of the shell as in the cut (A and B) but the tip of the arm-apparatus is always kept within the mantle cavity. The protrusion of the cirri, that is fore-ward and backward movement of the



B.

A.

arm-apparatus is best observed in younger individuals.

Among the specimens from Hyakkanzeki I found some shells, both valves of which are partially covered by some tubes of polychaetous Annelids, lying parallel to the longitudinal axis of the shell.

The peduncle has a great regenerative power. We often meet with large individuals with a very small and slender peduncle. As for the mode of regeneration I shall put it off till I study this structure more carefully.

As for the spawning habits of *Lingula* the reader is referred to my embryological paper.*

It is not an easy task to determine how long the life of *Lingula* is. To do this one must observe definite specimens in aquaria as well as in their natural habitat for many years. MORSE (73) states "they [*Glottidia*] were all of the same size and their life does not exceed one year" (p. 46). Somewhat later FRANÇOIS ('91) has declared that *Lingula* lives "au moins plus d'une année" (p. 232). The small individuals I was able to secure in the autumn at Misaki were 5 mm. in shell length on an average. Assuming that the growth of the shell goes on constantly and also that there is only one spawning season in the year, the fact that smaller individuals than the above size do not occur, proves that it takes one year for the larvae to grow up to this size. To attain the maximum length (35 mm.) of the shell at Misaki at the same rate would require 7 years. Accordingly, the conclusion is not unreasonable, I believe, that at Misaki *Lingula* lives for five years or more on an average.

That *Lingula* could have lived and survived throughout the whole geological periods is due, one would naturally suppose, to their great power of withstanding unfavorable conditions. This is proved by the fact that *Lingula* lives for a considerable lengthe of time in aquaria even after the water has become spoiled and foetid. A remarkable case justifying the above supposition has been brought to my notice

* N. YATSU "On the development of *Lingula anatina* BRUG." Jour. Coll. Sc. Vol. XVII. (*in press.*).

by Mr. HATTA, Professor of Biology in the Peer's School. Near Kumamoto there is an inlet called Matsubasé which forms a part of the Bay of Ariaké. The vast area of the inlet is covered by a sandy flat (Kitadasu) in which *Lingula, Tapes, Cytherea,* etc. are found in a great abundance. At every low tide thousands of the poor people crowd on the flat to dig the edible Lamellibranchs. In his collecting trip to that district in July 1887 Mr. HATTA observed the following striking facts. It was after a season of heavy rain which lasted twenty days or more that he visited that bay. The sandy flat was found entirely covered by a torelably thick layer of muddg sediment which had been brought down by a brook (Asakawa) runniny into the creek. All the Lamellibranchs had been completely destroyed under these unfavorable circumstances and were found already putrified emitting a horrible smell, and poor villagers were very much vexed at having thus lost their living. To his great surprise Mr. HATTA found that *Lingula alone had continued to live in as excellent a condition as it had ever been.*

It is a very striking phenomenon that *Lingula* has continued to live since the Cambrian period and much more so that its form has undergone but little change during such a vast length of time. There is an interesting incident which I have recently learned from PROF. DEAN. It is as follows. MORSE succeeded in carrying home to America with him living specimens of Japanese *Lingula,* and he had satisfaction of placing living specimens upon a ledge of Cambrian limestone *among the primaeval but hardly different shells of their ancestors !*

Lingula had already acquired as long ago as the Cambrian period an organisation most favorable for facing all the ambient conditions, physical as well as chemical, that have taken place since that time, and there seems to have been no necessity for improving their adaptations to the environment.

Zoological Laboratory,

Imperial University, Tokyo.

October, 1901.

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The Salmon and Trout of Japan.

BY

David Starr Jordan.

Of all the families of fishes none offer greater difficulties to the student of classification than the *Salmonidæ*. This is due to the extremely close relation existing among the species themselves and to the great range of variation offered by the individuals. No fishes respond more quickly to the influences of environment, none vary so greatly with the conditions of food supply, and none show greater changes with the different conditions of seasonal and sexual development.

Having carefully examined all the many specimens of salmon and trout obtained by Mr. Snyder and myself in the waters of Japan, in the summer of 1900, I am able to point out the distinctive characters of the species represented in this collection, which includes all the species thus far ascribed to the Japanese fauna.

1. The Sake or Dog Salmon ; *Oncorhynchus keta* (Walbaum).

The genus *Oncorhynchus* Suckley includes the salmon of the North Pacific, six known species in all. It is characterized by the increased number of anal rays, branchiostegals and gill rakers. Its species are resident in the sea, ascend the rivers to spawn, do not feed in the spawning season, and hence except when land-locked do not feed in fresh waters. The males become hook-jawed and greatly distorted in the spawning season, and after depositing the eggs and milt all of both sexes die.

The largest of the Japanese salmon is the Sake, called Dog Salmon on the American coast and Haiko in Siberia, *Oncorhynchus keta* (Walbaum). It reaches a weight of 10 to 15 pounds and runs in the fall in the rivers of Hokkaido and northern Hondo. In the character of its

flesh it is inferior to all the other salmon. For canning it is entirely worthless, the flesh being pale and becoming soft and pulpy when boiled. As a salted fish its rank is higher and many hundred thousands of pounds are sold each year in Japan.

The question is sometimes raised, why cannot salmon be put in tin cans with profit in Japan as well as in the United States? Why do the Japanese rivers produce inferior salmon? Simply because they are occupied by an inferior species. The Sake is found also in Puget Sound, Canada and Alaska, but it is everywhere rejected by the Salmon-canners and used only as salted by the Indians.

It is a matter of great economic importance for the government of Japan to substitute a better salmon for the Sake. The most valuable of all salmon, largest in size, finest in flesh, and most prolific is the American Quinnat or King Salmon *Oncorhynchus tschawytscha.* This species is easily transplanted, reaches an average weight of 22 pounds, and for every purpose is superior to any other salmon. I urge the planting of this species in the Kitakami and the Ishikari Rivers as a matter of vital importance to the fishery interests of Japan.

The Sake may be known from other Japanese salmon by its larger size, its mottled color, its broad tail, and especially by the medium size of its scales, there being 160 to 170 in a lengthwise series from head to tail. The fishes called *Oncorhynchus haberi* by Dr. Hilgendorf belong to *Oncorhynchus keta.* We have the Sake from Ishikari River, from Aomori and Hakodate.

2. The *Yezomasu* or Hokkaido Salmon; *Oncorhynchus yessoensis* Hilgendorf.

All the smaller salmon as well as the large trout are called in Japan *Masu,* and neither fishermen nor literary men seem to make any distinction among the three or four species confused under that name.

The present species is known at once from all the others in Japan by its very small scales, there being about 195 in the lateral line. The only other salmon-like fish having scales so small are the fresh water

gray-spotted trout, Iwana, Amemasu, and the Ayu.

This species is found only in Japan. It reaches weight of about eight pounds, and it is caught and salted with the Sake, to which it is probably not much superior. Our specimens are from the Ishikari River and from Aomori, besides a number of small ones said to be from the Daiya River at Nikko.

3. The *Gimmasu* or Silver-Salmon ; *Oncorhynchus kisutch* Walbaum.

This is the smallest of the true salmon, rarely exceeding six pounds in weight. It is common in the rivers of Northern Japan, as also in Siberia, Alaska and British Columbia. On the American coast it is known as Silver Salmon, and to the Russians as *Kisich*. Like the two preceding it ascends the rivers in the fall, and it ascends small streams as well as large ones. As a food fish it is regarded in America as superior to the Dog Salmon (Sake), but much inferior to the Red Salmon (Benimasu).

From the salmon thus far mentioned it is known by the large size of its scales, which number about 125 in a lengthwise series. It lacks the large number of gill rakers found in the *Benimasu*. It has more anal rays than the Yamabe, and it lacks the black spots on the base of the dorsal characteristic of that species. The dorsal fin in *Oncorhynchus kisutch* is always tipped with inky black at all ages and stages, and by this character the species can usually be known. As it is called Silver Salmon in America, it will not be improper to use the equivalent name *Gimmasu* in Japanese. Our specimens are from Otaru, Aomori, Osatsube and Ura River. This is the species wrongly called by Hilgendorf *Oncorhynchus perryi*.

4. The Benimasu or Red Salmon ; *Oncorhynchus nerka* (Walbaum).

This species, the handsomest of the salmon, may be known by the large number of its gill-rakers, about 36. It runs in the spring, weighing from four to eight pounds, and has a great liking for cold lakes. In such localities it often becomes land-locked, never descending to the sea, and when so placed it reaches a very small size. In running from the sea,

its color is bright blue and silvery, without spots. In the fall it becomes very red, when it is known as the Red-fish, or in Japan as the Benimasu. In spring it is called Blue Back. The young specimens are faintly spotted, but those land-locked are often profusely marked by black spots.

The flesh of the *Benimasu* is rich and delicate, much superior to that of the other Japanese salmon and inferior only to the American Quinnat Salmon, *Oncorhynchus tschawytscha*. The range of the species is northern. In America it is not found South of the Columbia. In Alaska and Siberia it far out numbers all other species and furnishes the chief product of the canneries. In Japan it is said to be known only in Kushiro in Northern Hokkaido, where dwarf examples enter Lake Akan. From Lake Akan our specimens were received through the courtesy of Mr. Nozawa of the Museum of Sapporo.

5. The Yamabe or Mountain Trout; *Salmo perryi* Brevoort.

In all clear streams through Hondo and Hokkaido, trout are found in abundance. Small ones are found in small streams and large ones in larger rivers, while those weighing ten or twelve pounds are often taken in the sea, especially in the north. To the small ones, the name Yamabe, with its variants Yamabai, Yamami and Yamomi, is given. The large ones are called *Masu* by the fishermen, who do not discriminate between them and the salmon.

They belong, however, to a different genus, *Salmo*, characterized by the presence of not more than 13 anal rays, not more than 13 branchiostegals, and not more than 20 gill-rakers. The sexual changes are much less than in *Oncorhynchus*. The species feed chiefly in fresh water, and as a rule the individuals do not die after spawning.

In all its stages of growth, the Yamabe may be known by the presence of black spots along its back and dorsal fin, 3 to 5 on the base of the dorsal being especially conspicuous. The scales are from 130 to 140.

It is always a good food fish, its flesh being firm and red, much like that of the Atlantic Salmon, *Salmo salar*. It is an excellent game-fish,

active and vigorous, taking the hook readily in the mountain streams.

The fish called *Salmo macrostomus* by Günther is the same as *S. perryi*. There may be other species of true Trout or *Salmo* in Japan, but all that we have seen certainly belong to one species.

Our specimens are from Lake Chuzenji, Kinu River at Utsunomiya, Daiya River at Nikko, Otani River near Nikko, Maebara and Karasaki on Lake Biwa, Kawajiri in Rikuchu, Kitakami River, Aomori, Hakodate, and the market at Tokio. It is the only trout or salmon found by us in Lake Biwa. In Lake Biwa, the fish is called Amenouwo.

Besides the native Yamabe two other species of *Salmo*, the American Land-locked Salmon (*Salmo salar sebago*) and the European Brook Trout or Forelle, (*Salmo fario*), have been introduced into Japan. The latter species, which much resembles the Yamabe, I found in Chuzenji Lake.

6. The Ito-Uwo or Blackiston's Trout ; *Hucho blackistoni* (Hilgendorf).

Most interesting of the Japanese trout is the long, slender pike-like species, called for its slimness the Ito-Uwo. This belongs to the genus *Hucho*, characterized by its flattened head, large mouth, and by the absence of teeth on the shaft of the vomer, which is formed as in *Salvelinus*. The scales are silvery, finely speckled with black, and in this and other respects, the genus is intermediate between *Salmo* and *Salvelinus*. The anal fin is short as in *Salvelinus*, and the gill rakers are few. The scales are about 113. Two species of *Hucho* are known, one, *Hucho hucho*, from the Danube, the other, *Hucho blackistoni* of Japan.

Hucho blackistoni is found in mountain streams of the north where it said to reach a length of $2\frac{1}{2}$ feet. Our specimen, received through the kindness of Mr. Nozawa, is from Kushiro. We have examined others from Nemuro, Chishima, Settsu and from Heigun River in Rikuchu.

7. The Iwana or Rain Charr ; *Salvelimus pluvius* (Hilgendorf).

The genus *Salvelinus* containing the charrs, red-spotted and white-

spotted trout, is characterized by its very small scales and by the form of its vomer, in which the shaft is depressed out of line with the head of the bone, and is without teeth at any age.

The species are all delicate, swift, brightly colored fishes living in mountain streams and lakes, not descending to the sea except in the far north. In general, the charr are the most vigorous of the trout, the most gamy and most prized by the angler. The pale spots are bright red when the fish lives in dark pools, yellowish in lakes, and grayish when the fish goes into the sea. All *Salmonidæ* become silvery after a stay in salt water. The *Iwana* is the only pale-spotted species found in Hondo. It may be known from *Salvelinus kundscha* by the smaller size of its spots, always smaller than the pupil. In *Salvelinus malma*, the spots are still smaller, and the mouth is smaller, not reaching beyond the line of the eye.

Our specimens are from Lake Chuzeuji, Ohata River at Aomori, and Kawajiri in Rikuchu. The species is often called *Amenouwo*, but that name is used also for the Yamabe.

8. The *Malma ; Salvelinus malma* (Walbaum).

This fine charr which is very close to the Iwana abounds in the Aleutian Islands, and westward to Komandorski, the Northern Kuriles and is recorded from Decastris Bay in Manchuria. It differs from the Iwana in the smaller spots, and smaller mouth. We are, however, by no means certain that the Iwana is more than a southern variety of this species, as the differences are very slight.

9. The Amemasu or Yellow Spotted Trout ; *Salverinus kundscha* (Pallas).

This charr may be known at once by the large yellowish spots, larger than the pupil. It is a northern fish, abundant in Kamchatka, rarely seen so far to the southward as Hokkaido. Our specimens are from Petropaulsky, Tareinsky and Nemuro. We have examined others from Shinbeshi and Iturup Island. Brevoort records it from Hakodate.

10. The *Ayu* or Sweet-fish ; *Plecoglossus altielis* Schlegel.

The Ayu is a dwarf Salmon, with the teeth of the jaws modified in a very peculiar fashion, as serrated plates. It is found in all the rivers of Japan throughout the four main islands. It is one of the most delicious of food fishes, and from its abundance one of the most valuable. It is of all the Japanese fishes the one which best deserves introduction into other regions. It would doubtles thrive in the clear swift stream of California and Chili, as well as in those of New Zealand and Mexico, and probably in England aud France as well. Its white flaky flesh, similar to that of the smelt or even finer is peculiarly delicate and nutritious. Our specimens are from Same, Ishikari River, Aomori, Matsushima, Tokio, Nikko, Morioka, Sendai, Gifu, Lake Biwa, Wakanoura, Kobe, Hiroshima, Osaka, Kurume, Nagasaki and Taihoku, Formosa.

On a new Enteropneust from Misaki, Balanoglossus misakiensis n. sp.

BY

Hisato Kuwano.

Since the description by ESCHSCHOLTZ, of *Ptychodera flava*, the first Enteropneust mentioned in literature, thirty species of this group have been reported up to the present date, from different parts of the world by different writers. But our knowledge in regard to the Enteropneustic fauna of our part of the world remains as yet very scanty. Only two species, *Glandiceps hacksi* MARION and *Dolichoglossus sulcatus* SPENGEL have been reported from the Main Island of Japan. Of these the second species has been left with a rathar meagre description owing to the lack of specimens. Under these circumstances, I have thought it worth while to devote myself to a study of the animals of this group found in the vicinity of Misaki and I have succeeded in gathering four or more different species.

The present species is one of these and appears to me to be new to science. The animal is found in a sandy flat in the cove of Moroiso, opposite the Marine Station.[1]

The habitat is limited to a small area of the flat exposed at the time of spring tides. It is one of the gregarious species and lives in the same locality with two different species of *Balanoglossus* DELLE CHIAJE, one of which is smaller while the other is larger.[2]

Though the animal is one of the burrowing spacies, I have not found it deeper in the sand than at the most two feet in depth, and have never

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1.) I have been told by Dr. Oka and by K. Awoki, Collector in the Marine Station' this species is also fouud in the sandy beach of Tateyama, Province of Awa.

2.) The occurrence of different species of Enteropneusts in the same locality as co-inhabitants have been frequently observed, as *Ptychodera flava* and *Glossobalanus hedleyi* in Funafuti, *Ptychodera flava* and *Spengelia porosa* in Lifu and *Glossobalanus ruficollis* and *Balanoglossus carnosus* in New Britain. (Hill, 1898, p. 205; Willey, 1899, p. 244.)

found it among the meshes formed by the roots of Zostera which flourishes here and there over the flat, unlike the above mentioned smaller species which is often found among such meshes.

In natural condition, this species lies always horizontally and does not make any building over the flat, while the larger co-inhabitant stands vertically with up-turned anal end and makes a sand cone over the opening of its burrow, on which castings are always found.

In a large percentage of specimens one, two or more of a small commensal crab, yellowish brown in colour, are found in the same burrow creeping about over the body of the worm.

Like some other known species, the animal has an odour resembling that of iodoform. This is so strong that by smelling the sand we are able to know where the animal is to be found. Besides, the animal emits readily a bright phosphorescent light making it a beautiful object in the course of shore collection at night.

Though I am unable to say decidedly that the animal practises autotomy, it is at least very fragile so that it breaks off easily to pieces in spite of a cautious treatment and the fragments of the caudal or even the hepatic region often turn themselves inside out.

They seem to have a power to regenerate the lost or injured portions of the body, it is certain that at least the proboscis and the posterior portion of the trunk are capable of being regenerated from the remaining portion.

The breeding season may be given as mid-summer (from the end of July through August.)

Now I will pass into the descriptions of some important anatomical characters of this species leaving the details to be published in a report which I am preparing on this and other forms.

FAM. PTYCHODERIDÆ, *Spengel.*

GEN. BALANOGLOSSUS, *Delle Chiaje.*

Balanoglossus misakiensis, n. sp.

External form (Fig. 1):—Proboscis subconical; proboscis-pore opens slightly to the left of the dorsomedian line of the proboscis-neck; collar high cylindrical; on the dorsal side of the anterior surface of the collar (in

front of the insertion of the proboscis-neck), a number of transverse epidermal groove are constantly seen; five epidermal zones and collar grooves are distinct; genital pleuræ are free from the posterior rim of the collar and their free edges do not come in contact with one another at the anterior portion, while posteriorly they end abruptly, just anterior to the hepatic region; in some specimens they may extend themselves along, and just outside, the anterior series of the hepatic saccules; branchial tract is in the shape of an elongated isosceles triangle with a posteriorly turned apex, on each side of which a deep abrupt depression of the epidermis makes its appearance[1] (Fig. 1.); hepatic saccules arrange themselves more or less regularly one after another and present cushion like epidermal thickenings richly supplied with mucus glands; epidermal strips paired and are limited into the abdominal region; Epidermis presents an annular markings in the caudal region and a semi-annular in the ventro-lateral surface of the branchiogenital region while in the hepatic region, it makes fine cross markings, all of which are interrupted by the sagittal median lines of the body; in the branchial tract, epidermis is divided up to a series of

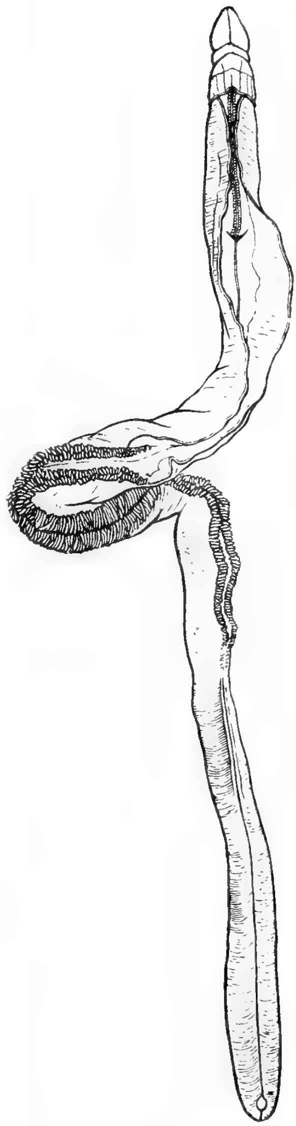

Fig. 1.
Dorsal view of a preserved specimen.
($\frac{1}{4}$).

1.) We have similar cases in *Glossobalanus hedleyi* (Hill, 1898, p. 340.) and especially in *Glossobalanus ruficollis*, in the later of which "the depression is localised in the posterior end of the branchial region" and Willey suggests its strong resemblance to the dermal pits of *Spengelia porosa* (Willey, 1899, p. 263 and 275.)

square areas ; anus dorso-terminal.[1] (Fig. 1.)

Colour :—the ground colour is of an uniform ochre-yellow, proboscis and collar groove are of faint yellow ; in sexually immature animals, genital pleuræ are of a deep yellow while in the sexually matured they are of dirty grey in female (due to the colour of eggs) and of yellow in male ; the hepatic region commences with a few of brick-red saccules followed by many of dark brown saccules which are again followed by a number of large yellow saccules passing over into a long stretch of green saccules.

MEASUREMENT : (*in mm.*)

	Prob.	Coll.	Branch. reg.	Gen. reg.	Hep. reg.	Caud. reg.
Length . .	7	9	40	62	140	125
Width . .	9	7				

Total length ca. 400 mm.

INTERNAL STRUCTURE.

Proboscis :—The circular muscle layer is interrupted by the dorsal insertion of the pericardium ; longitudinal muscle fibres spring in the proboscis wall near the bottom of each proboscis-canal and are inserted on the anterior portion of the wall, across the circular muscle layer, with an attenuated high refractile, difficultly staining terminal portion, simple or branched; dorsoventral muscle-plate extends beyond the front end of the stomochord[2] ; ventral septum stops short behind the anterior extremity of the stomochord ; right dorsal proboscis-canal ends blindly while the left opens to the exterior through a proboscis-pore ; the parietal layer of the connective tissue presents an alveolar structure[3] (Fig. 2), while the splanchnic layer

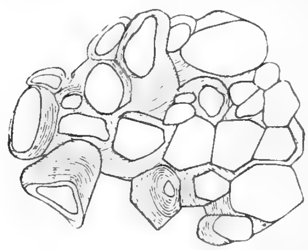

Fig. 2.

Alveolar structure of the connective tissue in the proboscis cœlom. ($\frac{1}{12}$ imm.×4).

1.) This is only case among known Enteropneusts.

2.) In this species I did not find any actual transition of fibres from the dorsal to the ventral beyond the apex of the stomochord in accordance with the description of *Glossobalanus hedleyi* by Hill (1898, p. 335–336), and unlike that of Spengel, Delage and Hérouard. (Spengel's Monograph, p. 460 ; Delarge and Hérouard : Traité de Zoologie Concrète, p. 10.)

3.) Such a structure has not yet been described in any other species.

makes a thick envelope over the central complex[1]; the anterior end of the stomochord bends dorsally in a remarkable manner; lateral pouches extends themselves ventro-laterally; pericardium is produced into two short anterior horns[2], each accompanied by the corresponding half of the glomerulus; Muscle fibre bundles along the inner surface of the pericardial wall fall in four distinct layers[3]—a ventral (dorsal to the central blood sinus), a dorsal and two lateral; nuchal skeleton has a prominent carina, two parallel crests, and short alary processes.

Collar: — Collar-canals parallel to the body axis; collar-pores open, on each side, into the common cavity of the most anterior four gill-pouches (Fig. 3, *cc.*); dorsal septum extends from the first root of the collar nerve-cord up to the posterior end of the collar cœlom; perihæmal spaces make together three dorsal grooves—two deep lateral and a shallow median—to clasp the ventral surface of the collar nerve-cord.

Trunk: — gill-pouches have no ventral cœcum and the most anterior four pairs

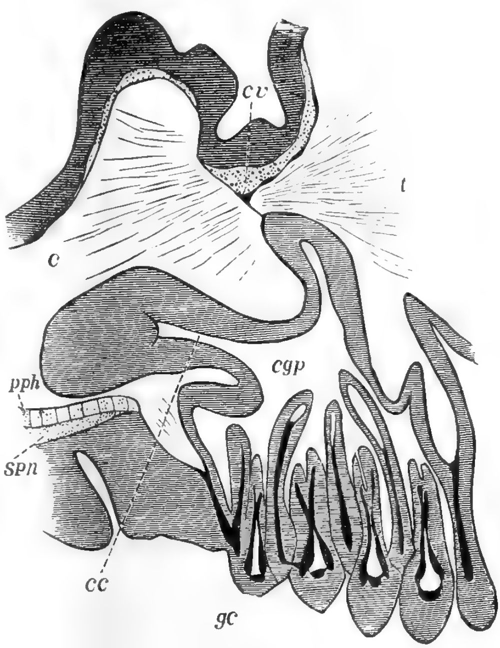

Fig. 3.

Sagittal section through the common cavity of the most anterior four gill pouches with the collar-pore at the anterior wall of the cavity.

c. collar-cœlom, *cc.* collar-canal, *cgp.* common gill-pouches, *cv.* circular vessel, *gc.* gut cavity, *pph.* peripharyngeal space, *spn.* splanchnic nerve fiber layer, *t.* trunk cavity.

1.) The same structure occurs in *Glossobalanus sarniensis* and *Balanoglossus australiensis* (Spengel's Monograph, p. 101 and Hill, 1894 p. 9.)

2.) Bifurcation of the pericardium is one of the characteristics of the Glandicipitidæ, and in the Ptychoderidæ we have only a parallel case in *Glossobalanus ruficollis* (Willey, 1899, p. 258.)

3.) They never make such a circular muscle layer as were suggested by Spengel (Monograph, p. 169 and p. 511.)

of them are confluent[1], on each side, to a common gill cavity which discharges to the exterior by a common gill-pore[2] (Fig. 3, *cgp.*); epithelium of the outer surface of the gill tongues is infolded into the tongue cavity; synapticula on each side of a tongue-bar is 15–17 in number; the respiratory and nutritive portions of the œsophagus are nearly equal in size; gonads coextensive with the genital pleuræ; secondary gonads well developed; postbranchial canal is directly continuous with the respiratory portion of the œsophagus and its anterior end carries the last pairs of the gill-slits[3]; the proximal origin of the lateral septa passes abruptly over the wall of the postbranchial canal from the gut wall and thence, the origin is again transferred on the epidermis to terminate on with the both origin and the insertion; in the hepatic region[4], the epidermis makes intersaccular involutions in a remarkable manner[5], ciliated grooves are paired and confined into the hepato-abdominal region; the grooves appear in their typical form only in the hepatic region, while

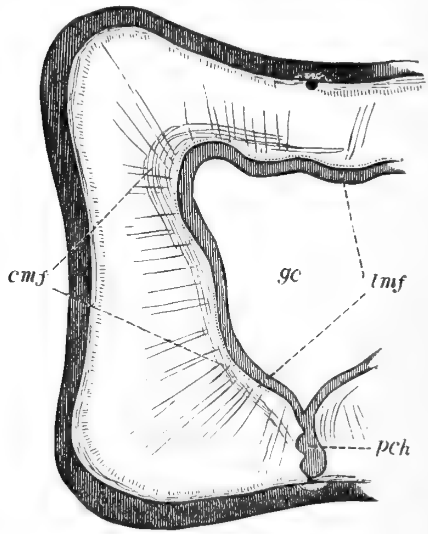

Fig. 4.

Transverse section through the anal region to show the circular muscle fibres going round the gut wall.

cmf. circular muscle fibres, *gc.* gut cavity, *lmf.* longitudinal muscle fibres, *pch.* pygochord.

1.) In *Glossobalanus hedleyi*, the most anterior two are confluent (Hill, 1898, p. 341).

2.) As far as its situation concerns, the common gill-pores correspond into the most anterior pairs of the gill-pores in other species.

3.) Though this structure was described in some of the genera *Ptychodera* Eschscholtz and *Glossobalanus* Spengel, in the member of the genus *Balanoglossus* Delle chiaje, it was first recorded by Willey only in *B. carnosa* (Willey, 1899, p. 254.)

4.) From my own observation on the living specimens of this species, I may say the vacuolation and bulging out of the epitherial cells lining the cavity of the hepatic saccules and the gut cavity are not the result of the action of reagents as were supposed by certain authors, but a normal physiological phenomenon accompanied with the secreting function of the digestive fluid.

5.) The intersaccular involutions of the epidermis may be probably same with that of *Spengelia alba* described by Willey (Willey, 1899., p. 283.)

in the abdominal region, they remain as only a thickening of the ciliated epithelium at the bottom of the grooves finding in the dorso-lateral angles of the gut wall; circular muscle layer makes its appearance just external to the longitudinal muscle fibres standing on the gut wall of the anal region[1] (Fig. 4, *cmf.*); pygochord dilates slightly along its distal margin (Fig. 4, *pch.*)

Nervous system :—Splanchnic nerve fibre layer is well developed in the buccal and pharyngeal walls; the lumen of collar nerve-cord discontinuous; roots two solid and directed posterio-dorsally.

Vascular system :—at the anterior portion of the proboscis wall, dermal capillaris makes four longitudinal stems, each lies respectively on the sagittal median and mid-frontal planes; ventral and dorsal medial

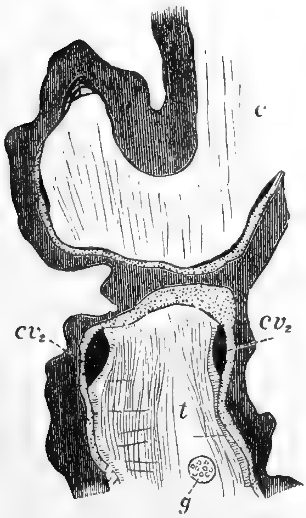

Fig. 5.

Horizontal section passing through the dorsal portion of the collar and the genital pleuræ showing the circular vessel at the anterior portion of the trunk.

c. collar-cœlom, *cv₂* circular vessel, *g.* gonad, *t.* trunk-cœlom.

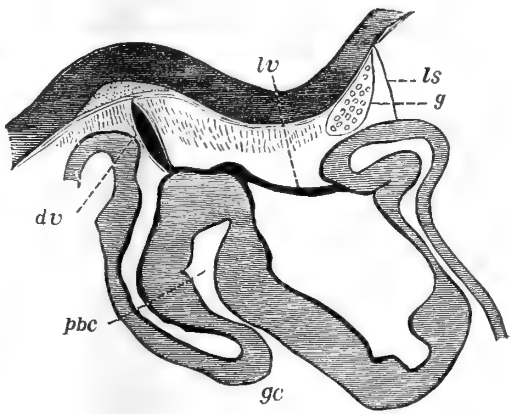

Fig. 6.

Transverse (slightly oblique) section through the anterior portion of the genital region showing the communication of the lateral vessel with the dorsal vessel and the capillaries of the gut wall.

dv. dorsal vessel, *g.* gonad, *gc.* gut cavity, *ls.* lateral septum, *lv.* lateral *pbc.* post-brafichial canal.

1.) This muscle fibres do not make a complete ring around the gut canal but interrupted by the pygochord.

2.) This arrangement of the dermal capillaries gives us a characteristic appearance in the cross sections though the proboscis-tip of this species.

glomeruli exist; just posterior to the circular vessel, another circular vessel, thicker than the former, goes round beneath the epidermis of the trunk making a loop in the genital pleuræ[1] (Fig. 5, cv_2.); lateral vessels stand in communication with the dorsal vessel and the capillarise of the gut wall, directly behind the last pair of the gill-pouches.[2] (Fig. 6, *lv*.)

Characteristics by which this species is distinguished from all other Enteropneusts are as follows:—

(1.) Definite arrangement of the longitudinal stems of the dermal capillaries in the anterior portion of the proboscis wall.

(2.) Occurrence of an alveolar structure in the connective tissue of the proboscis cœlom.

(3.) Occurrence of another circular vessel at the anterior portion of the trunk, immediately behind the circular vessel lying between the collar and the trunk.

(4.) Confluence of the most anterior four pairs of the gill-pouches into a common cavity, on each side, to discharge to the exterior through a common gill-pore. So, the collor-pores find theml selves at the anterior wall of the common cavities.

(5.) Communication of the lateral vessels with the dorsal vesse- immediately behind the last gill-slits.

(6.) Occurrence of circular muscle fibres at the anal region, just external to the longitudinal muscle fibres upon the gut wall.

(7.) Dorso-terminal position of the anus.

Finally, it may be of interest to mention that though this species is to be ranked, from its general structure, under the genus Balanoglossus Delle chiaje among the Ptychoderidæ, the structure is associated, as already pointed out in foregoing foot notes, with other structures characteristic for the members of other groups of the Enteropneust (cf. p. 3. 5 and 6.)

1.) Occurrence of such a vessel is only case among known Enteropneusts.

2.) Such a communication does not seem to have been established in any other species.

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CONTENTS:

Notes on a Specimen of Amphitretus obtained in the Sagami Sea.

BY

I. Ijima and S. Ikeda.

With Plate II.

During February 1897, Kuma, the collector of the Misaki Marine Laboratory, brought to Professor Ijima a very remarkable octopod of a beautiful and almost jelly-fish-like appearance, which was captured the day previous near Okinosé in the Sagami Sea. The collector stated that it had taken by mouth one of the hooks, baited with the flesh of a *Clupea*, of a long-line which was lowered to a depth of about 572 meters. The specimen is now preserved in the Museum of the Zoological Institute, Science College.

A water-color sketch was made of the animal while fresh. This is reproduced in Plate II, not altogether satisfactorily, but to the best of efforts, under the circumstances. We owe to the liberality of the Science College authorities that we are enabled to give that plate in this paper.

As the result of a careful examination of the specimen, conjointly done by us, we have come to recognize it as a member of the rare and interesting genus, *Amphitretus* Hoyle (Challenger Report, vol. XVI ; p. 67 ; pl. IX, figs. 7—9). Perhaps it may with advantage be considered even as identical with the single species as yet known of that genus, viz., *A. pelagicus*, which was described by Hoyle (*l.c.*) for the first, and to our knowledge also the last, time from a single, much contracted specimen, obtained off the Kermadec Islands in the South Pacific. True, there

exist certain discrepancies between HOYLE's description and the specimen in our hand; but these seem to us to be all such as may not improperly be ascribed either to individual differences or to the different state of preservation. At any rate, in the present state of our knowledge it is difficult to discriminate distinctive points sufficiently material to regard our specimen as specifically different from *A. pelagicus.*

The genus *Amphitretus* was made by HOYLE to constitute by itself alone a distinct family, the Amphitretidæ. It possesses "the character, unique amongst Cephalopoda, of having the mantle fused with the siphon in the median line, so that there are two branchial openings into the branchial cavity, on either side, whence the name."

In view of this high systematic importance of the genus and of its apparent rarity, we think no apology is needed for putting on record our observations on the specimen in question, and that perhaps all the less, since HOYLE's type seems to have been in a state much remote from being natural and well preserved.

Here it may be remarked that the curious octopod with "telescopic eyes," obtained by the "Valdivia" expedition in the Agulhas-Stream and figured, without description, by CHUN in his "Aus den Tiefen des Weltmeeres" (p. 535), bears a striking resemblance to *Amphitretus* in general appearance. In that figure the eye-bulbs are represented as freely projecting while the peripheral gelatinous layer, so conspicuously thick in our specimen while in the fresh state (see Pl. II), is scarcely shown at all. If it be that this condition was brought about by the shrinking of, and perhaps also by a partial damage to, the enveloping gelatinous tissue, it would not be too far going to presume that the "Valdivia" specimen is closely related to *A. pelagicus*, if not generically or even specifically identical. Professor CHUN's forthcoming monograph of the "Valdivia" Cephalopoda will likely contain matters that will settle the question.

Description of the specimen in the fresh state.

When the animal was first brought in, it still showed some life as

manifested in sluggish movements of the arms and other parts. It was soft, transparent and, as already mentioned, almost jelly-fish-like both in consistency and general appearance. The outline of the entire animal was like that of an elongate bell, rounded at the blind end and the edge of which ran out into the short free ends of the arms. The appearance was strikingly similar to that of *Alloposus mollis*, as figured by VERRILL (Bull. Mus. Comp. Zool., VIII; Trans. Conn. Acad., V) and especially of a new species of the same genus (*A. pacificus* IJ.*), known to us from the Sagami Sea.

The specimen was considerably compressed nearly but not quite dorso-ventrally; the eyes were turned somewhat to the right and the siphon to the left. This compression was however evidently due to the fact that the animal had lain overnight and suffered to become morbid in the position indicated in a flat vessel containing too little sea-water for the soft body to have retained its natural, probably cylindrical form. In this condition the total length measured 190 mm., and the breadth at the middle, approximately 70 mm.

A thick layer of a delicate, colorless and perfectly transparent gelatinous tissue covered up alike the body, the head and the umbrella continuously, exactly as in *Alloposus*. So far as the external outline was concerned, the layer exhibited no constriction or demarkation between any of the three parts just mentioned. It was over 20 mm. thick at the posterior end and 8—10 mm. at the sides; but it must be borne in mind

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* ***Alloposus pacificus*** IJ. N. sp. Two specimens have hitherto been obtained in the Sagami Sea and are preserved in the Sci. Coll. Museum. One is small, measuring only about 54 mm. in total length; the other is about 116 mm. long. Both without a hectocotylized arm. They closely resemble *A. mollis* VERRILL, except in the fact that the suckers are arranged in a single row for the greater part of the arm-length, being biserially arranged only in the free tip. The body is unusually compressed antero-posteriorly, its length (as measured from the posterior end to the mantle-edge) being about ¼ of the total length. There are two buttons at the siphon base, fitting into grooves on the inner side of the mantle. It is apparently either this arrangement or the depressor infundibuli that was called by VERRILL "the lateral longitudinal commissures," while his "median-ventral commissure" seems to be simply a part of the ventro-median septum, which, in this genus, is brought so far forwards that its anterior edge is partially visible from the outside in the middle of the mantle-opening.—IJIMA.

that the above-mentioned compression, to which the animal was subjected, must have unnaturally augmented the thickness of the layer in the marginal region at the expense of that both above and below. The same layer, as already indicated, extended itself over the arms and the webs in such a way that the external surface of the umbrella presented no elevations corresponding to the course of the arms below. At about the middle of the umbrella the layer was nearly 5 mm. thick over the arms, while the web measured as much as 12 mm. in thickness. It somewhat decreased in thickness towards the umbrella edge, which, nevertheless, presented a swollen appearance. On side-views of the arms it could plainly be made out that the inner surface of these had the same gelatinous layer as that on the outer and that the suckers lay buried in it up to their external opening. The external surface of the layer, and therefore that of the animal, was quite smooth and slippery.

Numerous small chromatophores of madder-brown to yellowish colors besprinkled the surface of the otherwise perfectly colorless and clear gelatinous envelope. In greater abundance and larger sizes were they found also in the deepest stratum of the layer, closely over the muscular tunic of the mantle, along the surface of the brachial muscles and on the eye-bulbs. According to the collector's statement, the animal, when in full vigor of life, should have displayed a vivid and beautiful change of color, now "intensely red" and then "nearly colorless."

Through the gelatinous envelope were indistinctly discernible the deeper outlines of the body, the head and the siphon. The body and the head, in this sense, together formed a roundish or ovoid mass, nearly transparent in the posterior portion but more opaque towards the head and the siphon. Between the head and the crown of arms there was a distinct neck-like constriction, which was not in the least shared by the outer gelatinous envelope. The arm-bases were rather opaque; however, there could be seen through them the faintly colored buccal mass, marking the fundus of the umbrella. For the rest the arms were sufficiently transparent as to show beautifully their ganglionic chain.

The ganglia corresponded in position with the suckers and, like these, became smaller and more closely approximated together towards the distal end of the arms.

The moderately large eyes are very conspicuous on account of its brilliant coloring. The bulbous inner end had a shining dark purplish or bluish ground-color, dotted with madder-brown chromatophores. The conical outer end was marked with rings of reddish, purplish and of a light color. The eye-bulbs projected out from the inner opaque head-mass, but were in reality not freely outstanding. Around them existed the peripheral gelatinous layer in nearly undiminished thickness as elsewhere in the neighborhood, and they reached the external surface only with the pupillar end.

The comparatively large siphon, as it lay obliquely anteriorly directed, was similarly covered up by the peripheral gelatinous layer, so that it nowhere projected outwards on the real external surface, except perhaps at the edge of its external opening. But this opening, as also those of the mantle-cavity, remained unascertained in the fresh state of the specimen. The way both the eyes and the siphon lie buried in the gelatinous tissue may be said as exactly comparable with the condition obtaining in *Alloposus*.

Of the contents of the mantle-sac there were some that could be oriented, though more or less indistinctly, from the outside. An ill-defined patch of deep purplish or bluish tint behind each eye probably had some relation to the liver. A median brownish tract, between the patches just mentioned indicated the stomach. On either side of the body the gills showed themselves as oblong whitish masses. Two pale yellowish spots behind and inside the gills were in all probability referable to the branchial hearts.

So far, the appearance of the specimen in the fresh state. Our further study was done after the preservation.

Description of the specimen in the preserved state.

For the preservation Flemming's fluid and alcohol were employed.

Woodcut 1.

Ventral view of the specimen after preservation. Natural size. Siphon and edge of the muscular layer of mantle, indistinctly indicated. Of the mantle apertures, only the right-side one is visitor.

Contrary to the desired result, the reagents have turned the specimen into a shabby object, incomparable to its former beauty. The change consisted in the loss of transparency, in the browning effect of the fixing fluid and in the contraction of parts in general, but especially of the peripheral gelatinous layer.

This layer is now reduced almost to the condition of an ordinary soft skin. It has shrunk so as to present a wrinkled surface and is no longer of such great moment in influencing the general shape of the animal as it was before. The specimen may now be said to bear a certain resemblance to the figure of *Amphitretus pelagicus* given by HOYLE in the Challenger Report.

The head and body together take up nearly one-third of the entire length. They are unnaturally flattened owing to the compression before referred to; otherwise they would have presented a nearly hemispherical-shape, much like the Challenger specimen.

The following are measurements taken some time after the preservation :—

Total length...	148 mm.
Breadth of body	45 „
End of body to mantle-margin	40 „
„ „ „ „ the middle point between the eyes...	45 „
„ „ „ „ mouth	56 „
„ „ „ „ siphon end	70 „
„ „ „ „ the umbrella edge between the ventralmost arm-pair	83 „
„ „ „ „ the umbrella edge between the dorsalmost arm-pair	115 „
Length of arm	86–96 „
Greatest thickness of arm	9 „
Diameter of largest sucker at the outer end	$2\frac{1}{2}$ „

It may be observed that our specimen is more than thrice as large as that described by HOYLE. If we are right in referring ours to the same species as his, the latter was probably a young specimen.

The most characteristic point of the family, *viz.*, the division of the mantle-opening into two separate, right and left apertures, can now be

satisfactorily made out. Already in the fresh state we noticed on either side of the siphon-base and laterally from the eyes two small spaces surrounded by somewhat crowded chromatophores, being themselves nearly free of these (see Pl. II). The spaces proved to indicate the openings of the mantle-cavity. The openings may be described as transverse, somewhat gaping, simple slits of about 10 mm. length. On the left side of the body, the opening commences at about 7 mm. distance laterally from the eye of the same side (see Woodcut 3, *l.m.o.*; p. 97). The right opening is found on the other side of the flattened body, evidently as the result of an assymetrical compression to which the specimen had been subjected (see Woodcuts 1 and 2, *r.m.o.*). We should say that in the natural cylindrical state of the body the openings occupy a position midway between the eye and the siphon-base on either side. They are both freely open. We mention this, because HOYLE found in his specimen one of the two openings closed, which closure be however regarded as abnormal.

The mantle-opening leads posteriorly into a compressed passage, the outer wall of which is given by the mantle but the inner, by a posteriorly directed, valvular fold, the lateral continuation of the siphon-base (Woodcut 2, *l.i.f.*). This fold is anteriorly continuous with the outer surface of the umbrella and has its thin free edge about 8 mm. inside of the mantle-opening.

Between the ventral ends of the mantle-openings there is an interspace of over 30 mm. breadth, covered over by a sheet of the now skin-like but originally gelatinous tissue, continuously connecting the surfaces of the mantle, the siphon and the umbrella. Through that skin is seen the mantle-edge or, more strictly speaking, the edge of the muscular tunic of the mantle. The edge-line extends uninterruptedly from one mantle-opening to another, and all along that line the muscular mantle-edge seems to overlap, and is adherent to, the muscular layer of the ventral wall of the siphon at base. It is apparent that, as was pointed out by HOYLE, the originally single mantle-opening had undergone closure in the middle, leaving only its lateral ends open. If we

suppose that in *Tremoctopus* or in *Alloposus* a fusion took place at the buttons as well as medianly from these between the mantle-edge and the ventral funnel-wall, much the same condition as that seen in *Amphitretus* will be the result.

The siphon in the preserved specimen is a flatly compressed tube, measuring about 28 mm. in length. It is 22 mm. broad at base and narrows anteriorly to a breadth of 9 mm. It lies flat on the umbrella, is covered over by the common skin and extends forwards for about one-third of the distance between the mantle-edge and arm-tips. The lateral edges are vaguely visible through the skin. The external opening is transversely slit-like, about 7 mm. long and bordered by somewhat prominent lip-like edges. The flat shape of the siphon may in a measure be due to the artificial compression. The head is indistinguishable from the body, being indicated only by the eyes. It is anyway small, that is to say, if we leave the outer gelatinous envelope out of consideration; otherwise it may be called large, being as broad as the body. Just the same condition obtains in *Alloposus pacificus.*

So far as could be ascertained by feeling from outside, we are inclined to assume the absence of a cephalic cartilage or of any other cartilage in the entire body. We have also failed to discover aquiferous pores.

The eyes are nearly pear-shaped with spheroidal base and rounded-conical outer end. They are about 13 mm. long. The bulbous base, about 10 mm. in diameter, is in its outer half studded with chromatophores on a dark back-ground; the inner half is of a lighter color. The outer rounded-conical or nearly hemispherical portion of the eye-bulb, about 6 mm. in diameter at base and not more than $3\frac{1}{2}$ mm. in height, is encircled basally by a light-colored zone and in the pupilar end by another zone of a dark brownish color. The latter incloses a whitish looking pupil of $1\frac{1}{2}$–2 mm. diameter. The two eyes are in contact with each other in their broadest portion. Their axes somewhat diverge outwardly and are at the outer end 12 mm. apart from each other. Between the eyes and over their contact point, there are seen two rather

conspicuous muscular threads, running from the nuchal band to the bases of the first arm-pair.

The jaws were not examined by us by cutting them out of the buccal mass.

In the umbrella the arms are now traceable, on both its internal and external surfaces, as ridge-like prominences owing to the shrinking up of the enveloping gelatinous tissue. By the same cause the interpodal edges of the webs have become much thinner and more deeply indented than was the case in the fresh state. The indentation is deepest between the ventral (4th) arm-pair, extending fully half-way up the length of these arms in a moderately outspread state of the web concerned. In the dorsal median web the deepest point of the indentation lies about one-third the arm-length away from the arm-tip. As regards the remaining paired webs, there are indications of their having unequally contracted on the two sides of the umbrella. We think we may say that they are all equal to the dorsal median web as well as to one another, both in extent and in the manner the ends of the free edge of each insert themselves to the enclosing arms. It is difficult to determine for what fraction of their length the arms are free at the distal end ; we may however approximately estimate it at $\frac{1}{6}$—$\frac{1}{5}$, without going much wide of the mark. Through the skin and especially when seen on the inner surface, the webs show numerous, thin, simple or branched muscular bundles, which run between the oppositely standing sides of every two adjoining arms (Woodcut 1).

The arms have unequally contracted in length (86—96 mm.). It may however be safely said that they are all subequal or nearly equal. They are about twice as long as the head and body taken together. Being somewhat laterally compressed, the thickest part may measure up to 9 mm. across in the lateral view and 6—8 mm. when seen from either outside or inside. At base they are somewhat narrower, and in the distal one-third of their length they again show a gradual tapering towards the slender, pointed tip. The cirri are not present. Nor is

there any sign of hectocotylization: the specimen proved to be a female on dissection.

The suckers number in all 32—35 to each arm. For a short stretch—say, of about 14 mm.—at the distal end of arms, they exhibit a tendency to an alternate biserial arrangement. In the remaining, by far the greater portion of the arms, they—fourteen or fifteen in number—are arranged in a single row.

The first sucker, counting from the base of arms, is about $1\frac{1}{2}$ mm. in diameter and is separated from the next following by an interspace of not over 4 mm. In the middle one-third of the arm-length—which space includes about five suckers, say the 7th—13th—the suckers attain largest size. Here they are set 6—8 mm. apart from one another in a series.

In the distal one-third of the arm they begin to become gradually smaller and more closely approximated together, until near the arm-tip they are half a millimeter or less in size and are placed in contact with one another.

Though more or less cylindrical in shape, the suckers are broader at base than at the truncated outer end and usually show a slight constriction near the latter. The height of the largest sucker, leaving the gelatinous envelope totally out of consideration, measures up to 4 mm.; diameter near the base, 3 mm.; that at the outer end $2\frac{1}{2}$ mm. The margin is thick and smooth; the cavity is deep and pore-like.

Some points of internal organization.

In order to obtain an insight into the internal structure, incisions and removal of parts have been made, so far of course as could be done without destroying the rare specimen.

Our attention was first directed to the histological character of the peripheral gelatinous layer. Studying this by means of both sections and teased preparations, we have found, in the first place, the external surface delimited by a fine, wrinkled, structureless membrane, on which

we have failed to observe epidermal cells. We can not but think that the epidermis had been lost before the specimen was put into the fixing reagent. In the second place, we have determined that it is by a modification of the dermal connective-tissue that the gelatinous tissue, almost similar in its character to that of a Medusa, is formed. We find it traversed in all directions by innumerable, very fine, elastic fibrils, amongst which are sprinkled stroma cells in large numbers. The chromatophores seem to have their seat chiefly in the superficial portion of the layer and also in its deepest part in direct contact with the muscular tunic soon to be mentioned. The same distribution of chromatophores is found in *Alloposus pacificus*. Here and there in the layer are seen blood-vessels containing blood-corpuscles, fine nerves sending branches to chromatophores and a few branching bundles of fibers which we take for muscular. On the whole it seems the tissue in question closely agrees both in structural and genetical respects with the corresponding tissue of *Alloposus mollis* as described by JOUBIN *; only, in *Amphitretus* the muscles in the gelatinous layer does not show a regular arrangement into definite layers as they seem to do in *Alloposus*.

Beneath the thick gelatinous layer and constituting the deeply situated tunic proper of the mantle, there are two thin (about .15 mm. thick) compact-looking sheets of tissues, which are well separated from each other by a layer of a soft and loose consistence. All these can be distinguished by the naked eye on the cut edge of the mantle.

The outer sheet exhibits on its external surface a number of large, flatly apposed chromatophores. For the rest it is composed of densely arranged muscle-fibers, of which we again distinguish an outer and an inner stratum, composed respectively of longitudinal and transverse fibers.

The inner sheet is somewhat firmer and again consists of two dense layers of muscular fibers, the outer transverse and the inner longitudinal.

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* Bull. Soc. Zool. de France. T. XX, p. 95.—Unfortunately, JOUBIN's "Contrib. á l'etude des Céphalopodes de l'Atlantique Nord" in Rés. Sc. Camp. Prince Monaco, Fasc. 9, does not stand at our disposal for reference.

2. Funnel and mantle-sac cut open on the ventral side.

3. Mantle-sac cut open on the dorsal side.

Both figures partially constructed.

an., anus.
ao., aorta cephalica.
a. v., abdominal vein.

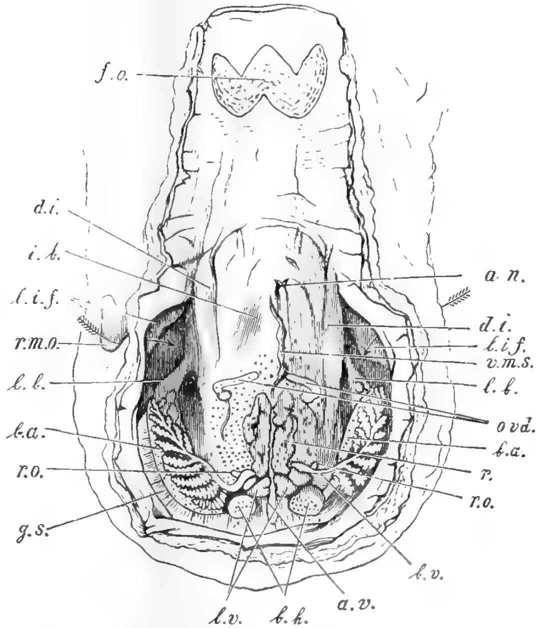
b. a., branchial artery.
b. h., branchial heart with small pericardial gland.
b. v., branchial vein.
d. i., depressor infundibuli.
f. o., funnel organ (Trichter-organ).

g., gill.
g. s., gill suspensorium.
i. b., ink-bag.
l. b., lateral band with ganglion stellatum.
l. i. f., lateral infundibular fold.
l. m. o., left mantle opening.

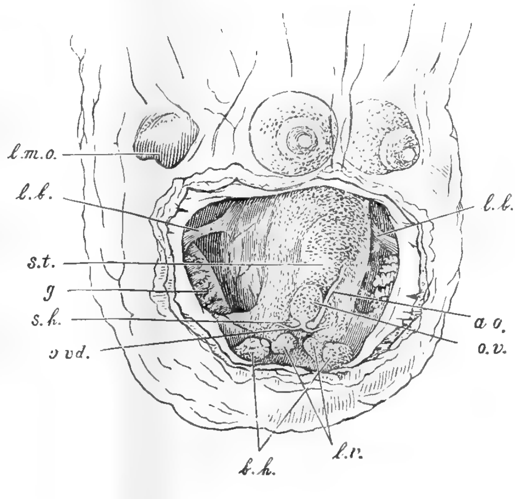
l. v., lateral vein.
ov., ovary.
ovd., oviduct.

r., renal organ.
r. m. o., right mantle opening.
r. o., renal opening.
s. h., systemic heart.
st., stomach.
v. m. s., ventro-median septum.

Woodcut 2.



Woodcut 3.



No chromatophores are found in connection with this sheet. The internal surface is probably in almost direct contact with the epidermis of the mantle-cavity.

The intervening space, between the two muscular sheets above mentioned, may be one millimeter or more in width and is taken up by an elastic connective-tissue, which is traversed crosswise by numerous, fine muscular bundles.

The wall of the siphon is essentially of the same structure as the mantle. In both sheets of its muscular tunic are found obliquely running fibers in addition to the transverse and the longitudinal.

Exceedingly remarkable seemed to us the structure of the arms. It may roughly be described as a thin-walled tube. The wall, not more than 0.15 mm. in thickness, is a firm muscular membrane in which the compactly arranged muscle-fibers form an outer circular and an inner longitudinal system or stratum, exactly comparable to those of the inner muscular sheet of the mantle. Apposed to the outer surface of the membrane are a number of chromatophores. The wide internal cavity of the arms is crossed diametrically by a large number of fine, white and glistening muscular bundles, the interspaces between which are apparently filled up by a gelatinously metamorphosed connective-tissue, quite like that of the integument except that it contains no chromatophores. By making a longitudinal incision, the muscular membranous wall of the arm may be laid aside and the internal ganglionic chain exposed, as if we were dissecting an earthworm or a Nematode.

The muscular wall of the arms is of course continuous with that of the suckers. The latter contain, inside the piston, a small space which is shut off from the internal arm-space by a thin membranous partition and which is traversed by numerous muscular bundles extending between the piston and the partition just mentioned.

Cutting open the siphon and the mantle so as to expose the visceral sac, we have ascertained the following points :

The ventral wall of the siphon and the ventral mantle, both as seen on the inner surface, are continuous but still show a boundary-line

between them, in that there exist a certain difference in the appearance of their innermost muscular layer. It can be made out on the cut edge that the original edge of the former adheres to the inside of that of the latter.

A short distance from the external siphon-opening is found the W-shaped funnel-organ ("Trichterorgan") with wrinkled surface. (See *f. o.*, Woodcut 2). It is of much the same shape as we know that organ in *Alloposus pacificus* and in certain species of *Octopus*. The two lateral ends of the organ are separated from each other by a space of 5 mm. on the ventral siphon wall. A valve is not present in the siphon; nor is there a trace of connective cartilages at the base. The depressores infundibuli (*d. i.*), disposed in the usual way, is thin and membranous.

The visceral sac is enveloped in a thin, transparent, visceral membrane, which is in many parts supplied with chromatophores. The same holds good also for *Alloposus pacificus*. The development of chromatophores in these parts evidently stands in relation with the transparency of the animal.

The visceral sac stands in connection with the ventral mantle by a ventro-median septum (*v. m. s.*). This is sagittally quite short and antero-posteriorly about 10 mm. long. Its anterior edge lies only about 4 mm. behind the erstwhile free edge of the mantle. The lateral bands (*l. b.*), on either side of the visceral sac, are thin and narrow. Near their outer end is distinctly visible the ganglion stellatum.

Shortly in front of the visceral insertion of the ventro-median septum and slightly to the left of the median line is situated the anus on the end of a prominence and provided with a pair of small papilla-like processes (*an.*). The rectum can be traced for a considerable distance along the ventro-median septum on the left side.

On the right of the septum is seen a blackish patch, which is caused by the presence of the ink-bag (*i.b.*).

Behind this region and symmetrically situated on both sides are a pair of small papillar prominences, on which the oviduct (*ovd.*) opens externally. (In Woodcut 2, the two openings of the oviducts have been

placed too close together). Through the visceral membrane is visible the terminal thickened portion of the oviduct. This runs from the external opening laterally and nearly horizontally for about 5 mm., then to bend backwards and mediad but soon to make a globular swelling, whence posteriorly the oviduct can be seen as a fine thread for a short distance before it becomes lost to the sight. On the dorsal aspect of the visceral sac (Woodcut 3), both oviducts are seen to emerge from the deep parts and to unite, right over the systemic heart (*s. h.*), into a very short unpaired duct which soon joins the oval-shaped ovary (*ov.*), situated just behind the stomach (*st.*).

For all the other visceral organs shown in Woodcuts 1 and 2, we consider no special remarks are needed.

The gills, 18 mm. long, have alternately arranged, convoluted lamellæ, about 10 in number on each of their sides. The branchial artery (*b. a.*) is thick and fleshy ; its surface, like that of the branchial hearts, is sprinkled with chromatophores. It is suspended from the mantle by a thin, mesentery-like band (*g. s.*), which is traversed across by a number of fine muscular bundles.

It will be seen from the above cursory account, as well as from the woodcuts given, that the arrangement of the organs in the mantle sac is essentially as in *Octopus* and related forms. In no less degree does it show resemblance to that of *Alloposus pacificus.*

Affinities of Amphitretus.

As regards the affinities of the genus, HOYLE assumed it to be most nearly allied to *Cirroteuthis*, as agreeing with each other in having the suckers arranged in a single row and the arms united by a broad web. We greatly doubt if these points of agreement taken alone can be of much weight in determining the affinity, especially in the presence of such important differences as were pointed out by HOYLE himself, as, for instance, the absence of cartilage, of fins and of cirri in *Amphitretus.*

On the other hand, it seems to us that a very much nearer ally is given in *Alloposus*, especially in *A. pacificus*. This species has in common with *Amphitretus* not only the similarly arranged suckers (see foot-note on p. 87) and the very extensive webs, but also many other points of fundamental importance as regards the histology and anatomy, to which attention has already been called. It may almost be said that, so far as is known, the only and the most essential distinctive character between the two genera, *Amphitretus* and *Alloposus*, consists in the presence of the ventro-median connection of the mantle with the siphon in the former.

VERRILL (*l. c.*), in diagnosing the family Alloposidæ and the genus *Alloposus*, has given that the mantle-edge is directly united to the head by "a median-ventral and two lateral longitudinal commissures," in addition to a large dorsal nuchal band. From this one might be led to think that the "commissures," here spoken of, may be something morphologically related to the ventro-median connection seen in *Amphitretus*. They may perhaps be considered as a forerunner of that connection in so far only as they serve to bring close together the free mantle-edge and the siphon-base; but the "commissures" themselves are, in our opinion, nothing peculiar to *Alloposus* (see foot-note on p. 87) In fact, the ventro-median connection of *Amphitretus* is totally unrepresented in *Alloposus* as in any other Cephalopod genera. Since now the "commissures" referred to forms the chief point in the characters of the family Alloposidæ of VERRILL, it may be questioned if that family can be held up as distinct from either the Philonexidæ or the Octopodidæ, to both of which it seems to show affinities in certain respects.

Be that as it may, we agree with HOYLE in regarding *Amphitretus* as a representative of a distinct family, the Amphitretidæ. As already indicated, this family probably has its nearest ally in the genus *Alloposus*. In the next place, it seems to us the family is more nearly related to the Octopodidæ than to any other family of the eight armed Dibranchiata, as shown in its organization.

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Preliminary Notes on Coeloplana.

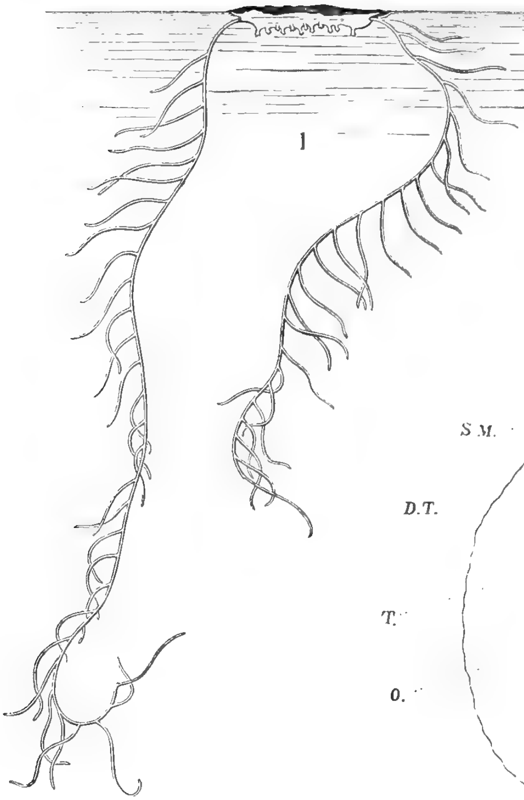
BY

James Francis Abbott, A.B.

In the summer of 1901, while enjoying the hospitality of the Misaki Marine Biological Station of the Tōkyō Imperial University, I was fortunate enough to find a number of specimens of a planarian-like form very closely resembling KOWALEVSKY's *Coeloplana.* The next summer my renewed search was rewarded by the discovery of several more, so that altogether some thirty or more specimens have been obtained. As unavoidable circumstances will prevent me from publishing extended results immediately, it has seemed best to briefly announce the discovery and describe some points of superficial observation, reserving the details of structure for a later paper. While doing so I must take the opportunity to express my gratitude to Dr. K. MITSUKURI, Dean of the Science College of the University, and Director of the Laboratory, for the unfailing kindness and courtesy with which he has aided me through out my visits to Misaki.

The animal, which—tentatively at least—will be considered a *Coeloplana,* occurs as two clearly distinct species. It is littoral in its habits and apparently wholly unfitted for life on the open sea. It possesses no vibratile plates or swimming cilia and cannot swim, tho in captivity it floats frequently on the surface of the water.

It is found principally on encrusting algae—*Zostera, Melobesia, &c.,*—which it resembles so closely as to make detection extremely difficult When found on the rocks it is frequently stretched out to a thin mass fo slime having little resemblance to anything animal. At such times



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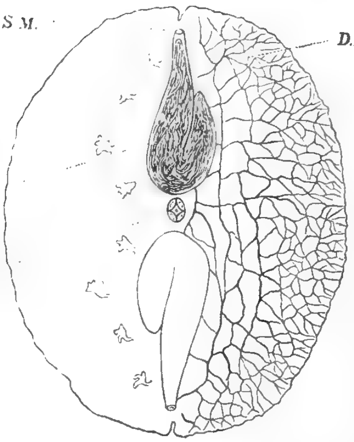

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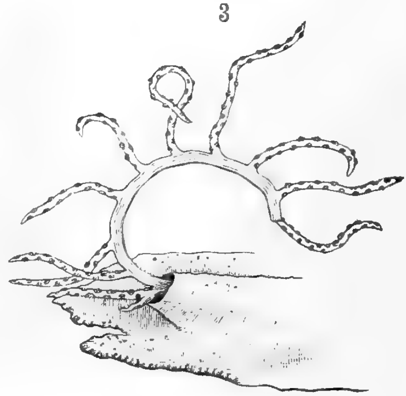

Explanation of Woodcuts.

Fig. 1. *C. mitsukurii*, in floating position. The branches of the tentacle are represented disproportionately thick, for clearness' sake.

Fig. 2. Diagram of gross anatomy of *C. mitsukurii*. *S.M.*, mouth of tentacle sheath. *D.T.* dorsal tentacles. *T.*, tentacle within sheath. *O.*, sense organ. *D.A.*, branches of digestive canals.

Fig. 3. *C. willeyi*. Mouth of tentacle sheath, showing the manner of partially extruding the tentacle when the animal is irritated.

the larger species will frequently measure 5 or 6 cm. in longest diameter; the same animal contracted, shrinking to one centimeter across. It seems to adapt itself to its surroundings in color, and heavily pigmented individuals as well as nearly transparent ones will be found in appropriate surroundings.

It is very sluggish and apparently inhabits a very limited field. The ventral surface is heavily ciliated, the dorsal not at all. The ventral surface is flat, and it never doubles upon itself as described for *Ctenoplana*. When dropped into the water the edges curl in, all around, and it falls through the water in a shapeless lump.

It floats on the surface of the water with ease, and at such times moves along the surface, snail fashion, on a film of slime. This frequently extends beyond the periphery so that it is possible to push the animal all about the jar with a needle, without coming within a centimeter of touching the edge of the body. I have never seen it floating except in captivity and it tenaciously resists being taken from the rock on which it is found.

Where one is found, others are quite sure to be, and the situations in which they are found are sometimes strongly suggestive of multiplication by division, tho no evidence has been obtained yet as to that point.

It would be as misleading as it would be useless to speak of front or back or sides in connection with this animal, at least as regards locomotion. It not only crawls in any direction whatever but it frequently goes in more than one direction at once and the two halves, starting off for opposite sides of the dish, often stretch the middle part to the breaking point. At other times, it turns and twists upon itself until, tho the outline may be fairly regular, the turns and coils of the internal organs show that the interior is much confused.

When floating *C. mitsukurii* frequently drops down its long tentacles which wave about in the water in very graceful fashion (fig. 1).

The dorsal surface is ordinarily heavily pigmented, the pigment being contained in large cells. Where the animal contracts, these cells

are approximated but when extended they are separated by wide interstices so that the general color of the animal becomes much paler, approaching transparent. About the periphery are thickly scattered dull yellow or whitish cells, sometimes forming a rather prominent border.

The most prominent feature of the animal is the two long chalky white tentacles which lie in great writhing snake-like masses on either side of the sense organ, usually visible from the outside. These are very long and very contractile, quite similar to those described for *Ctenoplana*. The secondary branches are covered with batteries of nettle cells. Except when floating as described above, they are usually retracted in the sheaths, occasionally with the tip projecting like a tongue. At other times, however when the creature is more animated, it throws out the whole tentacle in a cloud of white filaments, while crawling. And to watch it at such a time, shooting out and retracting the tentacles, moving along the side of the aquarium like a battle-ship in action, is truly a remarkable spectacle.

Touching with a needle will also frequently cause it to throw out the tentacles. (fig. 3).

The sheath is raised in a log-like ridge along the dorsal surface, ending freely a trifle back of a notch in the periphery. The mouth of the sheath is separated from the body to form a short retractable tube.

Next to the tentacles the most prominent thing to be observed is the network of anastomosing digestive canals, which ramify throughout the body (fig. 2). The creature's habit of constantly twisting itself out of shape makes it extremely difficult to plot with any certainty the course of the canals. There are three or four long channels that run more or less parallel to the axis of the tentacles and send out branches peripherally. At a point about half-way to the edge these branch much more profusely. The inner portion thus appears paler and clearer when viewed from above. There is no peripheral canal. The canals end blindly in finger-like processes. I have not been able to make out with certainty any

vertical canal running up to embrace the sensory organ as described by KOROTNEF but what observations have been possible seem to point to its existence in this form also.

The mouth is large, quadrangular, with colorless lips, lying directly below the sense organ. It opens into a rather thin-walled pharynx, which apparently is roughly four lobed. The canals branch out from above it.

The circulation in the canals is very evident and may be observed readily with a low power. The colorless fluid carries a quantity of irregularly shaped bodies which frequently flow both ways in the same channel. The circulation is apparently controlled solely by the motions of the animal.

On the dorsal surface are a series of club shaped processes which may be called dorsal tentacles. They are either entire or digitate and fringed; hollow and thin walled, and communicate with the digestive canals. The circulating fluid enters into them and the particles carried by it whirl about in eddies within the tentacle. The tentacle itself is contractile and may be withdrawn. When the animal is extended they usually become obliterated. They do not seem to be particularly sensitive, however, and may be moved about with a needle without being withdrawn. At the base there is usually an aggregation of pigment cells, tho the tentacle itself is colorless. As a result of this the position of the tentacles may be noted on an extended specimen by the color, when there is no sign of the tentacle itself. The arrangement is hard to make out, owing to the amoeboid habits of the animal mentioned above, but in the smaller brown form, they follow roughly the outlines of a figure 8, covering the dorsal surface, with the intersecting lines crossing at the sense organ. When floating on the surface the tentacles are usually pendant and swinging in the water.

The otolith is very small,—almost insignificant in the larger form. It lies in a depression closed by fleshy lips, but there are no accessory sensory tentacles as described for *Ctenoplana*, and no external guide

to axial orientation. Two semicircular bands of yellow cells, probably glandular, surround the otolith at the base.

Coeloplana willeyi. *N. sp.*

Average size :—one to two centimeters across. Very contractile and extensible ; amoeboid in movement. When killed, roughly circular in shape. In life, no consistent body-shape is maintained. Dorsal tentacles club shaped or cylindrical,—not branched or fringed. Color scarlet or carmine red, fading towards the edges to a yellowish pink. Chalky white spots about margins. Color deepest along the raised axis of the tentacle sheaths. Dorsal tentacles frequently with yellowish blotches at the bases.

Coeloplana mitsukurii. *N. sp.*

Smaller than the *C. willeyi* ; average size one centimeter or less. Body firmer, not amoeboid, consistently oval or almost circular. Prominent notch opposite tentacles. Dorsal tentacles with two to five digitate processes. Not nearly so contractile as *C. willeyi.* Arrangement of dorsal tentacles approximately in a figure 8, with the extremities of the figure interrupted, the intersecting lines at the sense organ. Color ;—dirty brown or brownish yellow. Less transparent than *C. willeyi,* frequently entirely opaque.

The two species are found together.

Oct. 1st, 1902.

On Two New Species of the Family Maldanidæ from the Sagami Bay.

BY

Akira Izuka,

Science College, Imperial University, Tokyo.

With Plate III.

Three species, representing as many genera, of the polychaetous family Maldanidæ have been recorded from the Japanese waters by M'INTOSH in the Challenger Report. They are as follows:

Maldane sarsi MALMGREN.

Nicomache japonica M'INTOSH.

Praxilla (Clymene) lankesteri M'INTOSH.

The list may be augmented by two more forms, both apparently yet undescribed. I propose to call these *Maldane gotoi* and *Clymene harai*, in dedication respectively to Professors S. GOTO and J. HARA, by whom the type specimens were collected and kindly given to me for study.

Both the new forms are from Yodomi in the Sagami Bay and a depth of 80 fathoms. The descriptions follow.

Maldane gotoi. *N. sp.*

Pl. III, figs. 1—8.

This is founded on two specimens. The larger one measures 42 m. m in length and 1.8 m. m. in breadth. The other is 34 m. m. long and 1.5 m. m. broad.

The worm, as preserved in spirit, is of an yellow ochre color with light bluish iridescence, except in a few anteriormost segments which present a brownish yellow hue.

In both specimens the cylindrical body is composed of 21 segments

The first or the cephalo-buccal segment is obliquely truncated in front at an angle of about 60° to the body axis (figs. 1 and 2). The truncated end, which faces dorsally and forms the cephalic plate, exhibits a median elevation laterally bounded by two slightly depressed furrows. This elevation is anteriorly continuous with a small protuberance at the ventro-median point of the cephalic plate edge. The dorsal and the lateral edges of the cephalic plate form a thin rim. This may be said as being serrated in the dorsal part, the serration becoming more pronounced as we follow it laterally on either side of the dorso-median line. The lateral portions of the rim had better be said as being furnished with fringing cirri of unequal lengths, rather than to describe them as very deeply indented (fig. 2). The mouth opens on the ventral side of the head end. In the larger specimen the proboscis is seen slightly protruded (fig. 3).

The second to fourth segments are of about the same length. The fifth and all the succeeding segments are slightly longer, though nearly equally long amongst themselves.

The last or the anal segment (fig. 4) has the ventro-posterior margin thinned out into a rim which shows four angular longitudinal edges. The dorso-posterior margin is expanded into a petaloid plume having six corners, each of which is prolonged into a slender cirrus. The anus lies dorsal to the petaloid plume, in the dorso-median line of the segment in question.

The cephalo-buccal and the anal segment are entirely destitute of bristles. The remaining nineteen segments are all setigerous.

The second segment possesses on either side a flattened group of short acicular setæ, of which two kinds, the slender and the stout (fig. 8, *a* and *b*) are distinguishable. Neither uncini nor capillary setæ occur in this segment.

The third to twentieth segments have each, on either side, two flattened groups of bristles representing the dorsal and the ventral ramus of the totally or nearly totally suppressed parapodium. The dorsal group consists of capillary setæ. These are present in two forms. Both are

long and slender, attenuating very gradually and uniformly towards the finely pointed end; but the one is excessively fine and smooth throughout (fig. 6, *a*), while the other, besides being much longer and stouter at base, is provided with bipinnately arranged spine-like hairs in the slender terminal portion, which on that account presents a plume-like appearance when seen under a high power (fig. 6, *b*, and fig. 7).—The ventral group consists of uncini arranged in a row. The uncinus terminates sometimes in three, and sometimes in four, hooks.

The tube of the worm was found in a greatly damaged condition, just enough to show that it is thin and membranous. Fine particles of bluish mud covered the surface.

The above described worm clearly belongs to the family Maldanidæ as established by SAVIGNY (System des Annelides, 1820). Further, it is referable to the genus *Maldane* GRUBE, notwithstanding that it does not quite agree with the definition of that genus as given by DE SAINT-JOSEPH (Les Annelides polychaetes des cortes de Dinard, 1894). The descrepancies consist in the presence of acicular setæ in the second segment, in which respect it seems to approach *Clymene*, and in the fact that the corners of the petaloid plume are elongated into cirri.

Clymene harai. *N. sp.*

Pl. III, figs. 9—12.

A single specimen lies before me. It is 92 m. m. long and 3.5 m. m. broad in the broadest region of the body.

The color, as seen on the alcoholic specimen, is a light yellowish ochre with bluish iridescence all over the body.

The cylindrical body (fig. 9) consists of 23 segments, of which 19 are setigerous. It may be distinguished into the four following regions: the fused cephalo-buccal or the first segment, the thorax, the abdomen and the tail.

The cephalo-buccal segment is slightly obliquely truncated. The truncated end or the cephalic plate shows a median fold which somewhat broadens antero-ventrally and which is bounded on either side by a

groove (fig. 10). The lateral and the dorsal margin form a thin and narrow rim, which is smooth edged, exhibiting neither serration nor cirri. The mouth opens on a gentle elevation on the ventral side near the anterior end of the segment. No bristles are present.

The thoracic segments, 7 in number, are about 3 m. m. broad. The anterior end of each surrounds the posterior end of the next preceding segment somewhat in the manner of a collar. The setæ are placed at about the end of the anterior third of each segment.

The abdominal segments, of which there are 12, are marked off from one another by simple grooves. The first 3 abdominal segments (3.5 m. m. across) are of about the same size and shape, being broader than long like the thoracic segments. From the fourth abdominal segment backwards, the segments grow successively longer at the expense of breadth, until the last abdominal segment is about twice as long as, but considerably narrower than the first abdominal segment. The groups of setæ in the first 2 abdominal segments occupy much the same position as in the thoracic segments. In the third abdominal segment they are situated at about the middle, while in all the following abdominal segments they lie approximately two-thirds the length of the segment away from the anterior end.

The tail consists of the three last segments. These are of nearly the same dimensions as the last abdominal segment but are destitute of bristles. The very last or the anal segment has the posterior border developed into a rim with finely and uniformly serrated edge. This rim surrounds a flatly conical elevation, the summit of which is occupied by the anus (fig.9).

The setæ on the first setigerous (i. e., the first thoracic) segment are all acicular, comprising two kinds differing in thickness ; but neither of these are capillary. Uncini are wanting.

In all the remaining setigerous segments, there are on either side a dorsal flattened tuft of capillary setæ and a ventral row of uncini. The capillary setæ are of two kinds (fig. 12, *a* and *b*) ; both are long, slender

and tapering to a fine point. The uncini (fig. 11) are curved and usually terminate with four distinct hooks.

The tube of the worm was found in fragments. It is membranous and covered with bluish mud particles on the outside.

The worm here described tallies well with the generic diagnosis of *Clymene* as given by DE SAINT JOSEPH, though the species is evidently a new one.

In conclusion I beg to offer my thanks to PROF. IJIMA for the aid rendered me in the preparation of this paper.

Oct. 23rd, 1902.

Explanation of Plate III.

Fig. 1. *Maldane gotoi* n. sp. Lateral view. (about $^5/_1$).

Fig. 2. Anterior portion of the body of the same. Dorso-lateral view. (More enlarged).

Fig. 3. Ventro-lateral view of the same.

Fig. 4. Posterior portion of the same. Postero-lateral view.

Fig. 5. Uncinus from an abdominal segment of the same. ($^{220}/_1$).

Fig. 6. The two kinds of capillary bristles from an abdominal segment of the same. ($^{220}/_1$).

Fig. 7. The pinnate terminal portion of a capillary bristle from the same. ($^{2000}/_1$).

Fig. 8. Acicular bristles from the first setigerous segment of the same. ($^{220}/_1$).

Fig. 9. *Clymene harai*, n. sp. Dorsal view. (about $^3/_1$).

Fig. 10. Anterior portion of the same. (More enlarged).

Fig. 11. Uncinus from an abdominal segment of the same. ($^{220}/_1$).

Fig. 12. The two kinds of capillary bristles from an abdominal segment of the same. ($^{220}/_1$).

On the Occurrence of Phoronis australis HASWELL near Misaki.

BY

Iwaji Ikeda,

Sci. Coll., Imp. Univ., Tokyo.

As is well known, *Phoronis australis* HASWELL is a species hitherto recorded only from Port Jackson in Australia. It has been known to inhabit deserted *Cerianthus* tubes at a depth of 27 m. in the locality mentioned.

Of late years a large and beautiful *Phoronis*, quite different from *P. ijimai* OKA, was discovered as one of the commonest animals near the Misaki Marine Laboratory. A remarkable fact it is that it so long remained without attracting the attention of the workers in the Laboratory. Possibly it was seen by many but was taken for tentacles of expanded Actinians, an illusion which, as will soon be seen, is not at all unlikely to happen.

After a careful study the *Phoronis* in question was found to agree quite well with the descriptions of *P. australis* as given by writers, especially BENHAM.* So that, I take no heed in considering it as specifically identical with that species. The fact is of interest as showing the wide geographical distribution of that species.

The circumstances of the discovery of the *Phoronis* near Misaki were as follows :

On August 10th, 1901, MR. HAYATA, then working in the Laboratory, obtained and brought in what he thought as a specimen of a gigantic Actinian. On our examining it together, I was agreeably surprised to find it to be simply a large gelatinous tube containing a large colony of

* Quart. Journ of Micros. Sci., 1890.

a species of *Phoronis* which was quite unknown to me before. On visiting at once the spot where it was obtained and which was only about four feet deep at a distance of a few minutes' rowing from the Laboratory, we have found the very Actinian, a *Cerianthus*, which was before supposed to have been captured, but which in fact remained behind, having been divested of only its gelatinous tube together with the *Phoronis* inhabiting it. The latter, being similarly colored as the tentacles of the *Cerianthus*, might easily be mistaken for these.

About a month later, after I have left the Laboratory, KUMA, the collector, reported that the same *Phoronis* turned out to be something very common, almost every individual of the *Cerianthus* being found in company with a more or less large colony of it.

During July in the following year (1902), I have had opportunities of verifying the truth of KUMA's report and of myself observing the *Phoronis* in its native habitat.

In the inlet of Moroiso, at the mouth of which is situated the Misaki Marine Laboratory, as well as in that of Koajiro, next north to the one just mentioned, the *Cerianthus*—a large species with deep reddish brown tentacles—inhabits the shallow muddy bottom at places in such abundance that one can not help treading upon it with every step. The gelatinous tube, in which it lives, may be as thick as one's arm. Excepting the smaller tubes, almost every one may be said to be tenanted by the *Phoronis*, as was reported by KUMA. At low tides the bottom is nearly exposed or is covered by only a few inches of water. The *Cerianthus* is then invariably retracted deep into the tube, but the upper end of this remains visible above the mud surface, together with the *Phoronis* colony, which radiates forth from the tube-opening simulating in a way the appearance of the expanded *Cerianthus* tentacles. Moreover, as before indicated, the *Phoronis* is of the same color as these; so that, we seem to have here a case of mimicry in which the helpless *Phoronis* not unlikely benefits itself, in an indirect way, of the protective influence of the nestle-organs possessed by the host, which at other times of the day will be found expanded at the identical spot. It is difficult to say if

the host derives any advantage from the presence of the commensal worms.

These are found, usually close together in a large number, near the upper end of the *Cerianthus* tube. The greater part of the body, covered by its own, loosely fitting, chitinous tube, lies imbedded in the gelatinous tube of the host in such a way that the posterior worm-end which is free from that of the neighbors, is directed downwards and somewhat obliquely outwards, while the anterior slender portion with the tentacular crown projects into the lumen of the host-tube, and thence outwards through the opening of the same

The worm may reach 90 mm. in total length and 4 mm. in breadth at the broadest part. The tentacles are 12—15mm. long; they are arranged in two and a half double coils on each side. That part of the body which lies within the tube-wall of the host is of a pink color, while the remaining parts are, as already indicated, deep reddish brown.

Closely behind the aboral lophophoral cleft are situated the anal ridge and the nephridial ridges, both showing the same characteristic features as were described by Benham. Over these ridges, as in fact over the entire deeply pigmented portion of the body proper, the skin in the fresh state exhibits closely set circular wrinkles.

The lophophoral chamber contains segmenting eggs and different developmental stages reaching up to such larvæ as are in possession of four pairs of tentacles. These larvæ are of a moderately large size, being on the whole relatively thick and short. The anal ciliated belt is disproportionately large; the collar and the tentacular bases are shaded with reddish brown pigments. In a few cases examined of free-swimming larvæ, evidently belonging to the species and which were obtained by means of a surface-net in the neighbourhood of the spot inhabited by the mother-animals, I have found the number of tentacles increased to 8—10 pairs; in other respects they were strictly comparable to those still contained in the lophophoral chamber. And, in these peculiar larvæ found at large, I recognize a form which, long before the mother-animal became known to me, once came under my observation in a limited

number of specimens among the plankton captured near the Laboratory. In the stage of development in which the free larvæ stand, it is unlike any of the four types of *Actinotrocha* which I have described from the waters near Misaki in 1901 (Jour. Sci, Coll, XIII, p. 534); but whether it should really be made into a distinct type, remains to be seen.

Note on Walteria leuckarti IJ.

BY

Isao Ijima, Rig., Ph.D., Rig.-Hak.

That beautiful fir-tree-like Euplectellid, which I have described under the name of *Walteria leuckarti*, is seldom brought up from the depths in a blameless state of preservation,—what is not to be wondered at, if we consider its large size and the fragile nature of its parts. At the time I have given its full description in the Studies on the Hexactinellida, Contribution I (Jour. Sci Coll. Tokyo, vol. XV), I have had several specimens to base it on ; but there was amongst them only a single specimen in which I thought the uppermost end of the tubular stem was preserved intact. On the strength of the condition presented by that specimen I have assumed that the stem is, as a general matter in the species, closed at the attenuated apex, the lumen communicating externally by those oscula found scattered on the sides. While I still maintain that individuals conforming to that assumption, especially as the result of the healing of a mechanical injury received, may occasionally be met with in the nature, I have been led to consider the presence of a small terminal osculum at the superior extremity as the normal condition. Three specimens have recently been acquired by the Science College, which all go to support that view.

In these specimens—all robust specimens, 2 ft. and over in height and with well developed branches—the stem is about as thick as one's little finger in the thickest part ; in the upper part it gradually narrows itself towards the apical end, which is in an almost perfect state of preservation in every case.

One of the specimens is remarkable for the fact that the stem is bifurcated, each stem after the bifurcation bearing the branches in the

usual manner One stem-end is injured, but the other is preserved intact without a sign of maceration. The latter is truncated, measuring about 2 mm. across at the tip. The terminal surface is occupied in the center by an orifice, about 1 mm. in diameter.

The second specimen shows the superior end shaped in much the same way. The truncated apex is here about $2\frac{1}{2}$ mm. in diameter, the central orifice measuring somewhat less than 1 mm. across.

In both the above specimens the small terminal orifice leads into a canal, which, on account of its small caliber and the dried state of the specimens, can scarcely be followed downwards to any considerable extent, in order to determine whether or not it stands in a direct and open communication with the lumen of the stem. I would probably have felt no diffidence in assuming the open condition of the passage, were it not for a circumstance in connection with the third specimen now before me.

Especially well preserved is the superior end of the stem in the third specimen. It is much broader than in the others. At a point 3 mm. from the tip, the stem is about $3\frac{1}{2}$ mm. thick; here is seen the last short lateral branch. Above this point it is somewhat swollen in a manner not unlike the end of the mouth-piece of a smoking pipe. The tip is here again truncated and, when seen from above, presents an oval outline, measuring 5 mm. by 4 mm. across. The orifice in the center is likewise oval, being about $2\frac{1}{2}$ mm. by $1\frac{1}{2}$ mm. in size. It is therefore surrounded by an edge of a not inconsiderable breadth, the appearance of which reminds one of the marginal cuff in certain other Euplectellids.

The moderately large size of the orifice in this specimen permits the cavity it leads into to be examined under the hand-lens. The felt-like inner surface presents no notable features; but the one point, which is rather against expectation, is the fact that the caveity is shut off from the lumen of the stem by a partition of the same felt-like appearance as the wall, although the lumen extends up right near to it with a diameter of not less than 2 mm. in the uppermost part. By simply looking into the terminal orifice, it at first seemed possible that the reflection of

light from the desiccated, pure white tissues might cause an illusion as to the real condition of the cavity in the deeper part. So a probe, made of a soft paper rolled up into a flexible thread, was made use of to ascertain the matter. From the side of the orifice, it could not be introduced for more than 4 or 5 mm., and by inserting it in the contrary direction from the stem lumen, it could never be managed so as to bring its end into view through the terminal orifice. It was evident that the terminal cavity really had a bottom,—that it was partitioned off from the lumen of the stem by a tissue exactly like that of the wall. Finally the sponge was carefully cut open at the part; but this did not help much in making the matter any clearer, owing to the disturbance that was inevitably caused to the brittle tissue by the scissors.

In the specimen in question, at any rate, I believe the partition was there. But the partition should probably be considered as only an apparent, not a real, one. For, it seems perfectly justifiable to assume that the spaces on both sides of it represent parts of one and the same excurrent space of the sponge, or in other words, that, in the natural state before desiccation, they stood in open connection with each other by one or more narrow excurrent canals running through it. This partition may then be considered simply as a thickening of the wall inwards so as to narrow the continuous internal passage at the part. The relation between the terminal cavity and the stem-lumen should have been just the same as that which obtains in certain pedunculated Hexactinellids (f. i., *Saccocalyx pedunculata* F. E. Sch., among the Euplectellidæ) betweeen the gastral cavity contained in the body proper and the hollow of the stalk, which latter is only an extension of the excurrent canal system. It of course remains to be seen whether this is to be looked upon as an indication that *Walteria leuckarti* is a stalked form, in which the hollow stalk is so extraordinarily developed as to represent the essential part of the entire sponge and in which the body proper forms so quite an insignificant portion at the apical end as to be said as being in the verge of disappearance. Above all things it remains yet to be established by future observations that the occurrence of the partition

I have mentioned is a normal and constant fact whenever the natural apical end is found preserved. But it may here be mentioned in anticipation that neither the presence of the branches nor of the oscula on the stem seems to stand on the way of the above speculation. For, the former are known to occur sometimes even on the basal disc for attachment, and the latter too seem to be something, which, as a general matter in the Euplectellidæ, may occur almost in any part of the sponge body. In *Placosoma paradictyum*, a new stalked Euplectellid which will soon be described elsewhere, oscula are present on the stalk as well as on the basal disc in addition to those on the body proper.

Be that as it may, a stalk is always but a part of the sponge-body, and there stands nothing against the indictment that *Walteria leuckarti* is a tubularly developed form, with a small terminal osculum at the superior end and a number of larger oscula on the sides.

The terminal osculum is in all probability the first formed in an early stage of the post-larval development; it should be strictly homologous with the similarly situated simple osculum of other Hexactinellids (*Malacosaccus*, *Saccocalyx*, the young of *Regadrella okinoseana*,—to take examples from amongst the Euplectellids). On the other hand, I hold the oscula on the sides of *Walteria leuckarti* as morphologically equivalent to those openings in certain Euplectellids (*Euplectella*, *Regadrella*, &c.), which were called "parietal gaps" by F. E. SCHULZE and "parietal oscula" by me. Now, whereas it is a general rule with the Euplectellids that the final outflow of water from the body is effected principally, if not entirely, at the superior end either by a simple large osculum or a congregation of separate orifices (sieve-plate meshes simulating it to the best under the architectural circumstances, and the parietal oscula, if present, apparently play only a subordinate rôle in the discharge of that function,—we seem to have in *Walteria leuckarti* a peculiar exceptional case in which the matter is reversed. Here, namely, the terminal osculum is abortive while those on the sides are so much the more developed as to be indubitably recognizable as such.

NOTICE.

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CONTENTS:

Bosminopsis in Japan.

Nebst Bemerkungen über einige andere japanische Cladoceren und den Hakonesee.

(Nach einem Vortrage gehalten in der „Deutschen Gesellschaft für Natur-und Völkerkunde Ostasiens" am 28. Mai 1902.)

VON

Eduard Klocke.

(Hierzu Tafel IV.)

Im Jahre 1895 veröffentlichte Jules Richard im „Bulletin de la Société Zoologique de France" die Beschreibung einer bis dahin unbekannten Cladocere, welche nicht nur eine neue Art, sondern auch zugleich eine neue Gattung der Entomostraken darstellte. Zwei Jahre später wiederholte Richard die Beschreibung in einem Aufsatze „Entomostracés de l'Amérique du Sud, recueillis par MM. U. Deiters, H. von Jhering, G. W. Müller et C. O. Poppe" in den „Mémoires de la Société Zoologique de France pour l'année 1897." Wegen der Aehnlichkeit des äusseren Habitus des Tieres mit den Bosminiden nannte der französische Forscher das neue Genus „*Bosminopsis*" und die Art speciell nach ihrem Entdecker „*Bosminopsis Deitersi.*" Richard teilte mit, dass die Cladocere in einem Süsswasser bei La Plata (Buenos-Aires) von Herrn U. Deiters erbeutet worden wäre und zwar nur in *einem* weiblichen Exemplare.

Seitdem ist, soweit der Verfasser der vorliegenden Arbeit wenigstens übersehen kann, des Tieres in der Litteratur nicht wieder Erwähnung gethan, bezw. ein neuer Vertreter der Gattung *Bosminopsis* noch nicht

wieder entdeckt worden. Desto mehr dürften die Fachkreise von der Nachricht überrascht werden, dass nicht nur *Bosminopsis Deitersi* in Nord-Japan vorkommt, sondern dass sogar eine zweite *Bosminopsis*-species in Mittel-Japan gefunden worden ist.

Der Autor dieser Schrift hatte sich, als er sich für einen mehrjährigen Aufenthalt in Japan entschied, dies auch in der Absicht gethan, einige hier noch brach liegende Gebiete der japanischen Faunistik zu bearbeiten, die ja in Hülle und Fülle vorhanden sind. Dass er dabei besonders sich der interessanten Gruppe der Cladoceren annahm, lag um so mehr auf der Hand, als einerseits noch verhältnissmässig wenig in der Erforschung dieser niederen Krebse hier gethan ist, und andererseits der Verfassser den grössten Teil der europäischen Formen von früheren Arbeiten [1] her kennt, so dass sich ihm interessante Vergleichungspunkte boten.

Um systematisch vorgehen zu können, wurde zuerst Hokkaido,[2] die nördlichste der vier grossen japanischen Inseln, in mehrmonatlichen jährlichen Reisen seit dem Jahre 1901 besucht, und hier war es auch, wo „*Bosminopsis Deitersi*" zum zweiten Male entdeckt wurde. Natürlich wurde auch die nähere Umgebung von Tokio nicht ganz vernachlässigt und besonders der in der Litteratur bereits bekannte, wundervolle Hakone-See in den Bereich der Untersuchungen gezogen. Dieser See lieferte die zweite Form der *Bosminopsis*-Gruppe, welche Verfasser nach dem bekannten japanischen Zoologen, Professor Dr. Ishikawa, dem langjährigen Schüler und Assistenten Weismanns in Freiburg

1.) Ed. Klocke. Zur Cladocerenfauna Westfalens, mit Nachträgen. Westfälischer Provinzialverein für Wissenschaft und Kunst. Jahresbericht der zoologischen Sektion. Münster i/W. 1892 bezw. 1894.

Ed. Klocke. Beiträge zur Cladocerenfauna der Ostschweiz. Berichte der naturforschenden Gesellschaft Zürich 1894.

2.) Die wissenschaftlichen Resultate der Forschungen auf Hokkaido werden nach der dritten Reise in diesem Sommer, wahrscheinlich schon im nächsten Winter als „Studien über Hokkaido, (hauptsächlich behandelnd: Säugetiere, Vögel, Reptilien, Cladoceren und die Süsswasserverhältnisse) in Tokio zum Abdruck kommen.

Bosminopsis Ishikawai

nannte.

Das Verdienst, das Tier zuerst gefischt zu haben gebürt eigentlich Herrn Dr. A. Fritze. Als derselbe Ende der 80-ger Jahre mit entomologischen Arbeiten in der Gegend des höchsten Berges Japans, des fast 4000 Meter hohen Vulkans „ Fujiyama " beschäftigt war, machte er in dem auf ziemlich halber Höhe des Berges liegenden „ Kawaguchisee " einige Fänge mit einem feinmaschigen Netze und übergab die Beute dann in Tokio Herrn Professor Ishikawa. Dieser untersuchte das Material und fertigte einige Zeichnungen an, von denen zwei hier abgebildet sind, liess die Sache dann aber wegen Überbürdung mit anderen Arbeiten liegen.

Als nun der Verfasser im Mai 1902 in dem am Fusse des Fujiyama liegenden Hakonesee die neue *Bosminopsis*-Art gefunden hatte und ein Praeparat derselben Herrn Ishikawa zeigte, erinnerte sich dieser der mehr als 10 Jahre zurückliegenden Fänge des Herrn Dr. Fritze, die nun aber leider nicht mehr existierten, und stellte dem Autor die damals angefertigten Zeichnungen zur Verfügung. Dabei stellte sich heraus, dass sich unter dem reichlichen Material auch der neue *Bosminopsis* befunden hatte, als dessen Heimat also wohl vorläufig die Seen des Hakonegebirges anzusehen sind.

Einige Merkwürdigkeiten mögen dabei allerdings nicht unerwähnt bleiben. Entomostraken aus dem Hakonesee sind bereits von Herrn M. Schmacker gesammelt und den Herren J. Richard und S. A. Poppe vorgelegt worden. Unter diesem Material fand sich kein *Bosminopsis*. Die in der „ Note sur divers Entomostracés du Japon et de la Chine "[1] von den Herren Poppe und Richard beschriebenen neuen Cladoceren-Arten : *Daphnia Schmackeri* und *Bosmina japonica* habe ich beide an der Fundstelle wieder konstatieren können.[2] Weiter ist bemerkenswert, dass die starren borstenartigen Schalenanhänge der von Fritze im

1.) Bulletin de la Société Zoologique de France pour l'année 1890.

2.) *Monospilus tenuirostris* fand ich an anderen Orten in der Umgegend Tokios, ebenso *Alona affinis*.

Kawaguchisee gefischten *Bosminopsis* nach den Zeichnungen Ishikawas— und auf die kann man sich bei der peinlichen Sorgfalt, mit welcher Herr Professor Ishikawa stets arbeitet und seinem grossen Beobachtungs-und Zeichentalent aufs Sicherste verlassen—bedeutend geringer und kürzer sind, als die von mir später im tiefer liegenden und grösseren Hakonesee gefundenen. Es ist also die Annahme nicht ganz von der Hand zu weisen, dass *Bosminopsis Ishikawai* später in den Hakonesee eingewandert ist und dass unter den veränderten Verhältnissen seine Schalenborsten mehr ausgewachsen sind. Das Tier kommt im Hakonesee nur pelagisch vor; sollen ihm die Borsten vielleicht das Schweben erleichtern? Wir hätten es dann mit einer Oberflächenvergrösserung zu thun, wie sie a. a. O. häufiger beobachtet ist. Auch bei den meist in grösseren Gewässern vorkommenden *Daphnia*-Arten, wie *Daphnia cucullata*, *Hyalodaphnia Kahlbergensis* und *Cederströmii* dürften die lang ausgezogenen Kopfschalen wie die Verlängerung der Schalenstachel auf Schwebegründe zurückzuführen sein. Ich will hierbei bemerken, dass ich die der *Hyalodaphnia Cederströmii* nahestehende Form von *D. cucullata* im „Sarumako," einem salzwasserhaltigen Haff an der Nordküste Hokkaidos (Ochotzkisches Meer) im vorigen August gefunden, von den übrigen gehelmten Formen aber bisher in Japan noch keine entdeckt habe.

Die Gattung *Bosminopsis* charakterisiert sich folgendermassen:

Habitus äusserlich den Bosminiden ähnlich.

Körper rundlich, mit einem deutlichen Einschnitt zwischen Kopf und Thorax.

Der niedrige Kopf ist vor dem Auge buckelartig stark gewölbt; er ist nach unten in conischer Form lang ausgezogen.

Die Fornices sind schwach; von oben erscheint der Kopf abgerundet.

Das Auge ist gross und mit zahlreichen Krystallkörpern versehen. Das Nebenauge fehlt.

Die Stirnborste entspringt sehr tief, weit vom Auge entfernt, auf einer kleinen Erhöhung des konishen Kopfendes.

Die Tastantennen setzen sich an die untere Verlängerung des Kopfes fest an; sie gehen im Winkel auseinander und tragen am Ende ein kleines dreieckiges Glied, an dessen Basis die Sinnesfäden entspringen.

Die Ruderantennen sind zweiästig. Jeder Ast hat drei Glieder. Der eine ist mit drei, der andere mit fünf articulierten Borsten versehen.

Die Schale ist rundlich, hinten in eine bald höher, bald tiefer liegende Spitze ausgezogen, die sogar in der Medianlinie des Körpers liegen kann.

Der hintere und untere Shalenrand ist mit mehr oder weniger zahlreichen, längeren oder kürzeren, starren Borsten versehen.

Von den Beinen sind fünf Paare deutlich sichtbar. Das sechste Paar ist ebenfalls im verkümmerten Züstande vorhanden.

Das Postabdomen ist ziemlich breit und verjüngt sich stark zum Ende hin. Es erhält dadurch eien fast dreieckige Form.

Neben den Schwanzkrallen tritt wenigstens ein starker Dorn charakteristisch hervor.

Die Schwanzborsten sind kurz, aber ziemlich kräftig.

Eine Verschlussfalte des Brutraumes ist nicht vorhanden.

Der Darm wölbt sich im weiten Bogen nach vorne breit vor. Er ist nicht geschlingelt.

Zwei Arten:

Postabdomen seitlich bewehrt. Tastantennen fast gerade, glatt. Schale glatt, durchsichtig.. *B. Deitersi.*

Postabdomen nicht bewehrt. Tastantennen nach hinten gekrümmt und mit kleinen Zähnchen versehen.

Schale reticuliert, granuliert .... *B. Ishikawai.*

Männchen beider Arten bisher noch unbekannt.

I

Bosminopsis Deitersi. (Taf. IV., Fig. 1.)

Richard hatte nur ein konserviertes Exemplar (Abbildung 1.) zur Verfügung und es ist erstaunlich, eine wie genaue und vortreffliche Beschreibung er von diesem einen Tiere machen konnte. Es ist hier nicht der Platz, seine Beschreibung zu wiederholen. Ich behalte mir das für eine spätere Arbeit, die eine Uebersicht über alle bis dahin in ganz Japan gefundenen Cladoceren geben soll, vor. Hier möchte ich nur die augenfälligsten Unterschiede zwischen den Zeichnungen und Erklärungen Richards und meinen Befunden geben.


Abbildung. 1.

Richard bildet neben seinem schematischen Bilde noch die unterste Schalenecke besonders ab, und zwar zeichnet er eine Borste und eine zahnartige, weiter unten liegende Erhöhung (mucron). Verfolgen wir dann das Hauptbild weiter, so sehen wir mehrere Caesuren in dem untersten Schalenrande. Sowohl der Zahn, wie die feinen Kerben sind in Wirklichkeit mehr oder weniger hervortretende Borsten von verschiedener Grösse und Dicke, beziehungsweise Insertionsstellen derselben. Der Schalenrand von *Bosminopsis* ist im Allgemeinen überhaupt sehr variabel. Ich habe sowohl Exemplare gefunden, welche fast vollständig dem Richardschen Bilde entsprachen, wie auch solche, bei denen die Borsten noch weiter verkümmert oder noch mehr ausgebildet sind. Einen systematischen Wert hat der von Richard gezeichnete Höcker keinesfalls. Der Vorsprung von welchem das Sinneshaar (soie frontale)

ausgeht, ist von Richard in der Einzelfigur, Abb. 2., genau ausgedrückt. Bedenken erheben sich hier nur gegen den Endteil der Tastantennen, der von Richard auf Kosten der Deutlichkeit vielleicht etwas zu gross gezeichnet ist. Bei allen meinen Exemplaren, auch bei *B. Ishikawai*, ist dieser dreieckige Endfortsatz sehr klein und hyalin, öfters nur von der Innenseite der Antennen sichtbar. An seiner Basis entspringen die von Richard nicht gefundenen Antennenhärchen (soies sensorielles). Mir scheint dieser Teil der Antennen überhaupt nicht ein wirkliches selbstständiges Articulum zu sein, sondern der dreieckigen Schuppe zu entsprechen, unter welcher auch bei den *Bosmina*-Arten die Tasthaare entspringen (Abb. 3.). Dazu will ich noch bemerken, dass mir bei keinem Exemplare eine solche Teilungsform aufgefallen ist, wie sie Richard in seiner Figur 30 zeichnet. Die Tastantennen schieden sich vielmehr stets in einfachen geraden Linien. Damit will ich natürlich nicht sagen, dass Richard falsch gezeichnet hat. Wenn sein *Bosminopsis* und die von Hokkaido auch zweifelsohne dieselbe Art vorstellen, so ist der räumliche Zwischenraum zwischen den Fundorten der Beiden doch gross genug, um kleine, unbedeutende Differenzen in die Erscheinung treten zu lassen. Auch der Unterschied in der seitlichen Bewehrung des Postabdomens erklärt sich so; ja er ist nicht einmal bei allen Hokkaido-Exemplaren vollständig gleich. Die nebenstehende Zeichnung (Abb. 4.) zeigt ein charakteristisches Postabdomen. Die Grösse des Richard-schen Exemplares stimmt mit der Durchschnittsgrösse meiner Exemplare nicht ganz überein. Die Länge der japanischen Exemplare ist etwas geringer und erreicht nur 0,38 mm. Man

Abb. 2.

Abb. 3

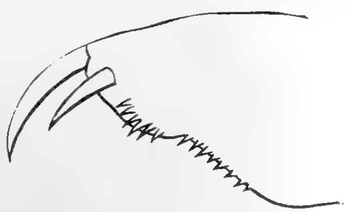

Abb. 4.

könnte aus diesen kleinen Unterschieden vielleicht eine besondere Japan-Varietät formen; ich habe das nicht gethan, da dies bei anderen Cladoceren ins Endlose führen würde.

II.

Bosminopsis Ishikawai. (Taf. IV., Fig. 2. u. 6.)

Wollen wir nun noch die neue Art *Bosminopsis Ishikawai* beschreiben, so ergiebt sich die Hauptsache schon aus den Abbildungen und den vorher angeführten Bestimmungsunterschieden. Characteristisch ist nicht sowohl die Krümmung der Antennen, sondern vor allem die Bedornung derselben (Abb. 5.). Die Bewehrung erstreckt sich nicht nur auf die Antennen selbst, sondern auch auf das untere Kopfstück. Am stärksten sind die Dornen am Innenrande der Antennen ausgebildet.

Abb. 5.

Der Kopf erscheint deutlich retikuliert. Die Schalen sind durch Einlagerungen (von Kalk?) wenig bis stark undurchsichtig. Sie machen dadurch einen schmutzigen Eindruck.

Die ausgezogene Spitze des hinteren, oberen Schalenrandes liegt meist bedeutend höher als bei *B. Deitersi.* (Siehe Tafel).

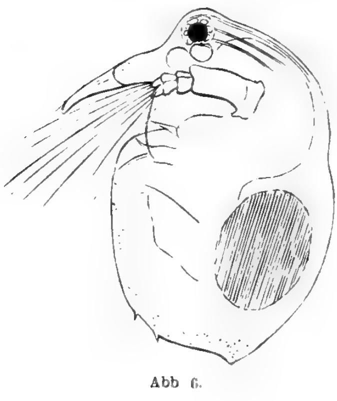

Abb 6.

Der hintere und untere Schalenrand ist im Allgemeinen bei den Hakone-Exemplaren weitaus stärker bedornt und erinnert beim ersten Anblick fast an *Ilyocryptus.*

Das schwächstbedornte Kawaguchi-Exemplar zeigt Abb. 6. nach einer Zeichnung Ishikawa's.

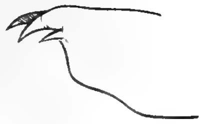

Abb. 6.

Das Postabdomen ist unbewehrt und weist nur die charakteristischen Nebenkrallen auf. (Abb. 7.)

Die Länge des Körpers beträgt 0,38—0,42 mm.

Alles Übrige stimmt mit der vorhergehenden Art überein, so auch die Ruderantennen (Abb. 8., Ishikawa del.)

Als Fundorte von *B. Deitersi* sind mir bis jetzt nur zwei kleine Seen bekannt, die beide im flachen Lande liegen und zur Niederung des Flusses Ishikari, des grössten Stromes Hokkaidos und zugleich Japans überhaupt, gehören. Im Ganzen habe ich in den letzten 2 Jahren 52 Süsswasserbecken in Hokkaido untersucht.

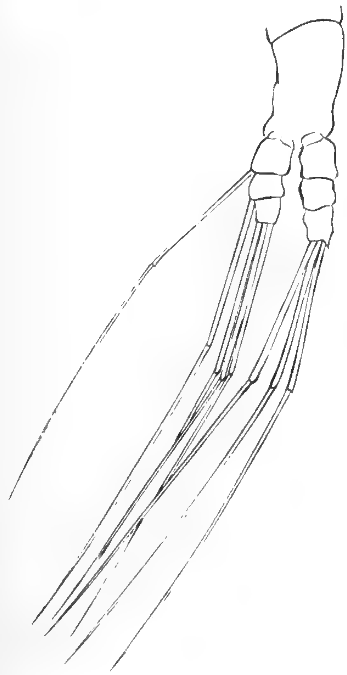

Abb. 8.

Die Fundorte von *B. Ishikawai* beschränken sich ebenfalls auf zwei Seen, den schon oben genannten Kawaguchisee und den Hakonesee. Immerhin sind die Fundorte der beiden Cladoceren, ihrer Lage sowohl wie ihrer Art und Weise nach, sehr verschieden. *Bosminopsis Deitersi* lebt in schilfumstandenen, flachen Landseen, *Bosminopsis Ishikawai* dagegen in tiefen Bergseen, die von schroffen Felspartien umgeben, eines starken Pflanzenwuchses ermangeln. Auch die klimatischen Verhältnisse sind verschieden, doch scheint das Klima bei der Verbreitung der Entomostraken keinen grossen Unterschied zu bedingen—finden wir doch von Norwegen bis Italien fast die gleichen Cladoceren; und heute kann ich schon sagen, dass die Cladoceren Japans, besonders der nördlichen Teile dieses gesegneten Landes kaum merkliche Unterschiede zwischen den mitteleuropäischen Formen erkennen lassen.

Von keinem See Japans wird im Auslande wohl mehr gesprochen als von dem oben mehrfach erwähnten Hakone-See. Seine landschaftliche Schönheit, die wilde Gebirgsformation seiner Umgebung und die Nähe des wundervollen, alles überragenden Vulkans Fujiyama locken alljährlich Tausende von Fremden an diesen romantischen Platz. Auch in der Geschichte Japans spielt der See eine grosse Rolle, wie er zugleich eines der ersten japanischen Wasserbecken war, das naturwissenschaftlich in Europa und Amerika bekannt wurde. Es mag daher wohl am Platze sein, in kurzen Worten die Verhältnisse dieses berühmten Sees zu skizzieren. Um seine Erforschung hat sich besonders Herr Akamaro Tanaka von der Adelakademie in Tokio verdient gemacht.

Der Hakone-See, oder vielmehr „Ashinoko" (Schilfsee), wie ihn die Japaner nennen, befindet sich südwestlich von Tokio, nicht weit vom Schnittpunkte des 139 Längen-und des 35. Breitengrades. Er liegt in vulkanischer Umgebung und verdankt wohl auch seinen Ursprung vulkanischen Kräften. Rings von steilen, grösstenteils bewaldeten Bergen umgeben, spiegelt sich bei klarem Wetter in seinem durchsichtigen Wasser das mächtige, fast stets mit Schnee bedeckte Haupt des japanischen Riesenvulkans, des mächtigen Fujiyama. Der Wasserspiegel liegt ca. 700 m. hoch ; er erstreckt sich in einer Länge von 6600 m. von S.O nach S.W. Die breiteste Stelle befindet sich im Südteile des Sees (2500 m.), die engste kurz von der Endausbuchtung weiter nördlich (300 m.). Das Wasser bedeckt einen Flächenraum von 2,145,521 Tsubo. (1 Tsubo=36 engl. Quadratfuss). Der Kubikinhalt des Seebeckens ist auf 113,428,800 cbm. berechnet. Die Durchschnittstiefe beträgt 16 m., die tiefste Stelle 48 m. Im See befindet sich eine submerse Insel, "Nakashima" genannt, mit einer Ausdehnung von 420 : 120 engl. Fuss. Ueber ihr sinkt die Wassertiefe bis auf 2 m. herab.

Die Durchsichtigkeit ist sehr gross. Ich hatte leider noch keine Gelegenheit, genauere Untersuchungen nach dieser Richtung hin im Hakone-See anzustellen. Im Allgemeinen traf ich aber in Japan, besonders in den Kraterseen Hokkaidos auf erstaunliche Resultate. So verschwand mein Fangnetz ans weisser Gaze in dem sehr tiefen "Shikotsuko"

Ende Juli 1901 erst bei einer Tiefe von 19,5 Meter. Forel hat die Sichttiefe des Genfer Sees auf 6,6 m. als Durchschnitt im Sommer (Juli 5,6, August 5,3) und 12,7 m. als Durchschnitt im Winter berechnet. Dabei gilt der Lac Léman als einer der klarsten, wenn nicht als durchsichtigster See der Alpen!

Obgleich es in den Hakonebergen empfindlich kalt werden kann und das Thermometer weit unter den Nullpunkt sinkt, ist eine Vereisung des Hakonesees noch nicht festgestellt worden. Nur in dem sehr kalten Winter des Jahres 1884/85 bildete sich etwas dünnes Eis an den Ufern.

Herr Tanaka fand während mehrjähriger Messungen eine Höchsttemperatur von 24° C. im September und als niedrigste eine Temperatur von 5°C im Februar. Ich selbst mass am 5. Mai des Jahres 1902 11°C in einer Tiefe von 10 Metern. Warme Quellen, an denen das Hakonegebirge reich ist, dürften der Grund sein, dass die Temperatur des Wassers nicht tiefer steigt. Von unterirdischen Quellen wird der See auch gespeist. Bemerkenswerte Zuflüsse sind nicht vorhanden. Dagegen fliesst das Wasser durch zwei Abflüsse, einen Kanal und den Fluss Haiyakawa (Schneller Fluss) ab. Der Fluss mündet nicht allzuweit von seinem Ursprunge, bei Odawara ins Meer.

Der Name Ashinoko (Schilfsee) könnte zu der falschen Vermutung Anlass geben, dass der Hakone-See stark mit Schilf bestanden wäre. Dem ist nicht so. Im See wächst kein Schilf, desto mehr sind aber einige Teile der Umgegend mit diesem hohen Grase bedeckt. Besonders auf dem Tokaido, der alten Heerstrasse nach Tokio, wächst Schilfrohr in Hülle und Fülle. Die hier vorkommende Art ist eine Varietät unseres gemeinen deutschen Schilfrohrs, *Phragmites communis* var. *longivalvis* Mig.

Schliesslich sei in Bezug auf den Hakone-See noch bemerkt, dass die Ufer steil bis sehr steil sind und nur wenig Raum für Wege und Ansiedelungen lassen. Die Europäer und Amerikaner, welche den See wegen seiner Schönheit, der heissen Mineralquellen in der Umgegend und des kühlen Klimas im Sommer jährlich in grosser Zahl besuchen, haben ihn nach den beiden kleinen am Ufer liegenden Badestädtchen Motohakone

bezw. Hakone "Hakone See" getauft. Unter diesem Namen ist er denn auch in der Wissenschaft bekannt geworden.

Der Erste, welcher im Hakone-See nach Entomostraken gefischt hat, ist wohl, der schon erwähnte Herr M. Schmacker gewesen. Ich bringe auf der beigefügten Tafel zwei Photographieen von *Daphnia Schmackeri* und *Bosmina japonica*, Poppe u. Richard, deren Artkennzeichen von diesen beiden Forschern bereits im Jahre 1890 vortrefflich geschildert worden sind.

Bezüglich der Abbildung von *Daphnia cucullata* bemerke ich, dass sich in meinem Material kein unverletztes Exemplar befand. Ich machte die Photographie daher von einem wenigstens der Form nach unbeschädigtem Tiere. Auffallend ist auch hier, wie bei *Bosminopsis Deitersi* und manchen anderen japanischen Cladoceren, dass die Maasse hinter den in anderen Ländern gefundenen ziemlich zurückbleiben. Die vorliegende *Daphnia* hat von der Helmspitze bis zum Endrande der Schale—also ohne Stachel—nur eine Länge von 0,58 mm. Exemplare von der Grösse der von mir selbst sonst in Europa Gefundenen kamen mir hier nicht unter das Mikroskop.

Erklärung der Tafel IV.

(Fig. 1—5 sind Microphotographien, aufgenommen mit einer mikrophotographischen Camera der Firma E. Krauss & Cie., Paris, bezogen von deren Filiale in Tokio. Fig. 6, ein Osmiumpraeparat, ist gezeichnet mit dem Zeichenprisma. Als optische Instrumente wurden Krauss-Zeiss-Instrumente benutzt).

Fig. 1.—*Bosminopsis Deitersi* Richard.

Fig. 2.—*Bosminopsis Ishikawai* Klocke. Stark behaartes Exemplar.

Fig. 3.—*Bosmina japonica* Poppe et Richard. Bei manchen Exemplaren sind die Tastantennen noch mehr unter den Körper zurückgebogen.

Fig. 4.—*Daphnia Schmackeri* Poppe et Richard. Mit Krauss-Zeiss Planar photographiert. Charakteristisch ist u.a. der gerade Schalenstachel.

Fig. 5.—Schale einer *Daphnia cucullata* aus dem Saruma-Haff am Ochotzkischen Meere.

Fig. 6.—Verlauf der Nerven am kopfende und den Tastantennen von *Bosminopsis Ishikawai.* Mit dem Zeichenprisma gezeichnet.

On a New Polygordius from Misaki

(*P. Ijimai* n. sp.).

BY

Akira Izuka.

Larvæ believed to be those of *Polygordius* have from time to time been obtained in the neighbourhood of the Misaki Marine Biological Laboratory without the mature worm having been discovered. During the last spring, however, I succeeded in obtaining, at a spot of the sea-shore close to the Laboratory, a large number of adult *Polygordius*, probably the generator of the larvæ mentioned and which I consider to represent a species new to science. The discovery may be worth recording, since all the species hitherto known * of the genus are from the coasts of Europe.

I propose to call the Misaki species

Polygordius Ijimai

in dedication to Professor Isao Ijima of the Science College, Tokyo.

The thin and cylindrical body measures 70–77 mm. in length and 0.6–0.8 mm. across in the middle part of the body, where this is broadest. The general colour of females is yellowish pink, lighter in tone in the

---

* Six in number, *viz.*:

1. *P. lacteus* Schneider. (Helgoland).
2. *P. apogon* M'Intosh. (Shetland).
3. *P. villoti* Perrier. (Roscoff).
4. *P. erythropthalmus* Giard. (Concarneau).
5. *P. appendiculatus* Fraipont. (Naples).
6. *P. neapolitanus* Fraipont. (Naples).

anterior region and deeper in the posterior—say, in the posterior $\frac{3}{4}$ of the body-length. This deeper tone of the colour is evidently due to the eggs contained in the region. The males are of a very light pink color, which may bear a milky-whitish tint on attaining sexual maturity. Both sexes show a slight iridescence all over the body.

In fresh specimens the segments are externally indistinct or scarcely recognizable in the anterior region, though they are always plainly indicated in the posterior half of the body. After preservation they are marked by distinct ring-grooves all throughout the entire body.

The mouth, situated on the ventral side of the anterior end, is subtriangular in shape. The cephalic lobe in front of it bears, as usual, a pair of horn-like tentacles which are widest at base and are directed antero-laterally. They are only about 1 mm. long. Eyes are wanting. There exists, on each side of the head and at about the level of the mouth, an oval-shaped vibratile pit, the greater axis of which is vertically disposed.

The body gradually narrows behind in the part adjoining the anal segment. This segment is broadest at base, where it is broader than the part directly in front of it. It again narrows towards the terminally situated anus. The anal margin is nearly entire or is at most wavy, forming obsolete lobes eight in number. In its anterior half the anal segment bears numerous papillæ arranged in a number of longitudinal rows or zones,—which arrangement, as also the peculiarities of the anal orifice, forms one of the characteristic points by which the species may be distinguished from all the others. Three filiform appendages occur on the anal segment: one on the dorsal side in the median line and the rest ventro-laterally on either side.

Observed on sections, a thick cuticle is found to cover the hypodermis, beneath which I have failed to discover ring-muscle fibres. Neither do these seem to exist inside the layer of the strongly developed longitudinal muscles, this layer being directly lined by the peritoneum on the inner side. A dorsal and a ventral mesentery suspend the intestine in the body-cavity. Neither longitudinal nor ring muscles are present in the intestinal wall.

The vascular system exhibits a general agreement with that of other species—as for instance, of *P. neapolitanus*—except in one important point. This consists in the fact that the consecutive lateral loops, present in a pair in each segment and which connect the dorsal and the ventral vessel, stand on either side in open anastomosis with one another by means of lateral longitudinal commissures. These evidently correspond to the blind vessels known to exist in certain species (f. i., *P. neapolitanus*) arising from a point midway in the course of the lateral loops. In the present species, they come into communication with the lateral loops towards which they are directed, instead of ending blindly before reaching these. On each lateral loop it is seen that the commissure coming from the loop directly in front finds its insertion at a point a short distance ventral to the origin of the next posteriorly following commissure. Therefore, the successive lateral commissures on either side of the body do not form an uninterrupted longitudinal vessel, as does the dorsal or the ventral vessel.—A pair of small vessels, arising from the points where the ventral vessel sends forth the paired lateral loops, seem to supply the intestinal wall.

The species contain nearly mature ova or active spermatozoa as early in the season as the end of March.

The worms described live along the lowest tide-mark and in or on a bottom consisting of shell-fragments, sand, pebbles and blocks of a rough sandstone. They are exceedingly active creatures, constantly moving the head-end and burrowing or creeping with remarkable ease. Notwithstanding this nature, they are excessively frail and fragile, breaking into pieces by the slightest cause or apparently even spontaneously when kept in captivity.

July 1st, 1903.

On the Development of the Sexual Organs and of Their Products in Phoronis.

BY

Iwaji Ikeda, *Rigakushi.*

With Plate V.

In *Phoronis ijimai* and *P. australis*, as in all other species of the genus, the ovary and testis are situated in the posterior part of the body, on one side of the stomach. When fully developed, they represent two elongate and loose masses of 1–2 mm. in length, lying side by side—the ovary dorsally to the testis—in close apposition with each other and nearly filling up a lateral chamber of the body-cavity in the region indicated. Clasped between the two organs runs the efferent blood-vessel. This sends forth numerous, branched or simple, blindly terminating capillaries, which may be distinguished into two series, the ovarian and the testicular, according to the organ they penetrate into. Of great importance are these capillaries in the genesis of the sexual glands, as giving the fundament for their development.

In young individuals—say, in all those which have not yet attained the full adult size—the sexual glands are without a trace. In their stead there exist only the said capillaries, the so-called cœcal or contractile capillaries, which, arising as slender thin-walled off-shoots from the efferent od-vessel, lie free in the body-cavity. The capillary wall consists of three layers, *i.e.*, (1) the endothelium, (2) the peritoneum and (3 the connective-tissue layer lying between the above two. Of these three layers the middle one is that which in the larger vessels bears the

character of a tolerably thickly developed muscular layer. Both the endothelium and the peritoneum are made up of the usual flat cells. Needless to say that all the layers are directly continuous with the corresponding layers in the wall of the efferent blood-vessel.

All the subsequent changes leading to the formation of the ovarian or the testicular tissue concern only the peritoneal layer of the contractile capillaries. It may here at once be mentioned that that layer has to serve for a time as reserve ground for certain nutrient matter and is then absorbed, becoming finally completely replaced by the sexual cells of likewise peritoneal origin. The changes begin to take place after the animal has attained nearly or quite its full size. Among the specimens of *P. ijimai* obtained and preserved in the months of December to May and of *P. australis* killed in September, I have found some individuals with the sexual organs already fully developed, while in others they were still in an earlier or a later stage of development.

As the prelude to the development of the sexual glands, a part of the cells forming the peritoneal layer of the capillaries transforms itself into a peculiarly characterised epithelial tissue, which has been called by Kowalewsky the "Fettgewebe" and by Cori* the "Gefässperitonealgewebe." That this tissue is derived from the originally flat peritoneum of the capillaries has been correctly pointed out by Cori. The peritoneal cells increase in number, although I have not been able to see direct proofs of cell-division. At the same time the majority of them, but not all, become bulky, growing more especially in height, which is due in a measure to the accumulation of the yolk-like inclosures soon to be noticed. This change, so far as I have seen, begins at the basal part of the capillaries, that is to say, near the junction of these with the efferent blood-vessel, and thence proceeds distally towards their blind ends. The peritoneum of the efferent vessel itself never participates in the above metamorphosis; it is seen to pass gradually and continuously into the now greatly thickened and much altered peritoneal layer of the capillaries at the base of these.

* Zeitschr. f. Wiss. Zool., Bd. 51, 1891.

Directly beneath that layer, and therefore interposed between it and the connective-tissue layer, there remain at wide intervals small and flat peritoneal cells which may be said to retain their primitive condition. These small cells may best be observed on longitudinal sections of the capillaries (Pl. V., fig. 2, *f.p.*). Irregularly scattered though they are, they may perhaps without impropriety be considered to form a fourth layer to the wall. Those cells are of great importance in that they give rise to the germinal cells. Not that all the capillaries which later stand in relation with the sexual glands undergo the above metamorphosis nearly simultaneously, but there may remain for a considerable length of time after some have completely gone through it, such others as are or more less belated in the process or have not even begun to show it.

A capillary after the completion of the change has increased in external thickness, though the calibre of the lumen remains the same as before. Or, it may be more proper to say that the capillary is now invested all around by a remarkably thickened peritoneum, consisting of columnar or pyramidal cells arranged in a layer. A cross-section (Pl. V., fig. 1) presents a wheel-like appearance. In the centre is the capillary lumen, lined by the usual endothelium which rests on a connective-tissue layer. Externally to this are arranged the large and tall peritoneal cells in a radial manner. As the result of this mode of arrangement, the enlarged cells are narrowed towards their inner end. The small perito neal cells which should occur at their base are very difficult to observe on cross-sections (and are therefore not shown in fig. 1).

The enlarged peritoneal cells exhibit a fine but distinct bounding membrane. The relatively small nucleus is always situated near their outer and broader end—often almost in contact with the cell-membrane at that end. The cytoplasm is of a clear appearance, being sparsely and finely granular ; it is lightly coloured by staining reagents. In certain preparations an indication of a reticular structure of the cytoplasm was observable, reminding me of the "Fadennetzwerk" described by CORI in the same cells of *P. psammophila* ; but that is certainly not a constant phenomenon in the species studied by me.

Inclosed in the cytoplasm are, as is well known, numerous yolk-like spheres of various sizes (fig. 1, *a*, *b*).* They are not crowded together, but are scattered throughout the cell-body. In the fresh state they are colourless, opaque and very weakly refractive. The larger of them may be nearly as large as, and sometimes even larger than, the blood-corpuscle; whereas the smaller may be as small as the nucleus of the same. All the smallest (fig. 1, *b*) are simple elementary bodies, which cohering in varying numbers, seem to compose the larger spheres (*a*). These are then, as are in fact apparent from their structure, to be considered as conglomerates of the smaller elements. Osmic acid blackens the spheres, as when the tissue had been fixed with Flemming's fluid. Iron-hæmatoxylin stains them so deeply that the conglomerate nature of the larger ones becomes obscured. Very good preparations were obtained by using corrosive-sublimate solution as the fixing reagent and by staining with Delafield's hæmatoxylin in combination with either eosin or Congo-red. Eosin invariably stains the spheres very deeply.

As will be shown, the above described spheres disappear—are evidently used up—during the development of the sexual cells, the epithelium itself dwindling away and finally likewise disappearing to give place to the genitial glands. Taken in all, it appears to me exceedingly probable, if not ndubitable, that the spheres are to be looked at in the light of a nutrient substance in reserve, which is needed for the development of the sexual products. Whatever they may be in chemical respect, physiologically they seem to be much the same as the fat. In accordance therewith, the modified peritoneal cells containing them may without impropriety be called the reserve-nutriment cells, or for the sake of brevity, simply the nutriment cells. The layer formed of them may conveniently be referred to as the nutriment layer.

Cori found in *P. psammophila* the so-called spindle-bodies, first

---

* Besides the yolk-like spheres here described, the cells in question contain in the fresh state a number of minute, refringent and reddish-yellow granules scattered in the cytoplasm. After the tissue is fixed and preserved, they are no longer to be seen. I am not in a position to decide whether they are pigments or a fatty matter.

described by KOWALEWSKY, not only freely floating in the cœlomic cavity but also contained in the nutriment cells. In *P. australis* I have met with the same bodies in the cœlomic fluid, but never in the cells just mentioned; and in *P. ijimai* I have simply never and nowhere come across them. They are evidently something of inconstant occurrence and therefore probably of no great physiological importance, so far at any rate as concerns the discharge of function by the nutriment cells. Another noteworthy point mentioned by CORI is the fact that he found, engulfed in the cells under question, bodies that appeared to him to be the remains of degenerating blood corpuscles. It seems to me that this matter requires confirmation before it can be accepted as a fact. For my own part, I have failed to find any indication whatever tending to support CORI's observations on the point.

It now lies in order to describe the formation of primary germinal cells. BENHAM* rightly stated that the sexual products develop from peritoneal cells of contractile capillaries, but the details of the developmental process have never become known; and as to the relation between the generative organs and the nutriment layer, nobody seems to have as yet gone into the matter

According to my observations, the primary germinal cells begin to appear on a capillary sooner or later after the full development of the nutriment layer. As already indicaded, they arise from, and by proliferation of, those small and flat peritoneal cells which remain at intervals at the base of the nutriment layer. This cell-proliferation commonly begins to take place near the base of the capillaries, thence proceeding gradually towards the free distal end. This extension is due to the addition of new cells which have arisen by multiplication of the small and flat peritoneal cells situated on the road of advance. The newly arisen cells—the oogonia or spermatogonia as the case may be—are nearly uniformly small and approximately spherical in shape; they form at the region a layer, which is two, three or several cells thick and which is at first covered over by the nutriment layer.

* Quart. Jour. Microsc. Sci., Vol. XXX, 1889.

It is henceforth necessary to treat of the ovary and the testis separately. I will take up the former first, as giving a clearer insight into the developmental process.

The Ovary and Its Product.—Closely following their first formation, the oogonia begin to differentiate themselves into the oocytes and the follicular cells, the two kinds of cells which go to form the entire ovarian tissue. The former are distinguished by the larger size, which of course becomes more and more pronounced with the advance in growth; the latter remain small and are arranged around and between the former. Each egg-follicle thus consists of a central oocyte enveloped in a single-layered follicular epithelium. Around and along the capillary the follicles range themselves in a layer. They show amongst them a considerable difference in size from an early period of their development. A definite rule seems not to exist as to the relative situation of the largest and the smallest follicles, though at a later stage of the ovarian development it is often noticeable that those more proximally situated on a capillary are on the whole the more advanced in growth.

As already indicated, the ovarian tissue is at first covered over by the nutriment layer. In inverse proportion as the follicles or the oocytes in that tissue grow in size, the overlying nutriment cells diminish in height (see PL.V., figs. 2 and 3); that is to say, they become smaller and smaller, while the inclosed yolk-like spheres constantly diminish in quantity. The smallest and simple spheres are the first that disappear, evidently as the result of resorption. This leads finally to the total disappearance of the spheres as well as of the nutriment cells themselves, after which the ovarian tissue forms the outermost layer of the capillary wall and is thus directly washed by the cœlomic fluid (fig. 4). It may be said in general that as the development of the ovarian tissue advances, starting from the capillary base, the nutriment layer gradually dwindles away before it.

At a certain stage in the genesis of the ovary, the numerous capillaries giving foundation to it may show the transformation carried out to various degrees. While some capillaries or capillary branches may

already be invested by the ovarian tissue right up to the blind end, others may exhibit it in the proximal portion only, the distal portion still retaining the nutriment layer to a greater or less extent. Occasionally there may exist even such as have just begun to bear nutriment cells and therefore remain quite thin in the distal part. With full development of the ovary, all the capillaries concerned in its formation should have the nutriment layer entirely replaced by the egg-follicles.

To follow the growth of the oocytes, it is at first generally spherical in shape, with the vesicular and relatively large nucleus situated in the centre. As it grows it soon assumes an ovoid or flask-like shape, being attached to the capillary by the narrower end. This is doubtless due to mutual pressure exercised by the oocytes at base, as they find attachment close together on the narrow axially running capillary (see fig. 4). The nucleus is now seen to occupy an eccentric position in the broader end of the egg-body. The follicular envelope is visible for some time as a flat epithelime showing compressed nuclei at rather long intervals; but as the egg approaches full size it becomes so distended and thinned out that it appears as a fine structureless membrane, in which the nuclei can no longer be made out. In small oocytes, such as are represented in fig. 2, the vitellus is finely granular and is deeply stained by basic stains, such as hæmatoxylin, gentiana-violet, *etc.* In more advanced stages, it is somewhat coarsely granular and then greedily takes up acid stains, such as eosin, Congo-red, orange-G, *etc.* instead of basic.

The large clear nucleus exhibits a net-work of linin; it is wide-meshed though densely arranged in immediate environment of one of the nucleoli, of which there can be distinguished two (see fig. 4, *E*) Both nucleoli are spherical and very distinct, their size growing in proportion with the growth of the oocytes. The one nucleolus (*n*) is distinguished by the fact that it consists of two parts: a small sphere which is but very lightly stained by nuclear stains, and another larger sphere which is deeply stainable. At first, while the oocyte is still very small, the former lies simply apposed on the surface, but later sinks completely into the substance, of the latter. In the stages shown in fig. 4, the nucleolus in

question (n in A, C, E) is in a state in which the smaller and little stained constituent is already completely inclosed within the other. The former, after the inclosure, swells and produces within it a few vacuoles. The second nucleolus (n'), in an early part of the ovogenesis, is of a homogeneous appearance, staining deeply by nuclear stains (fig. 4, *A* & *B*, n'). However, after growing in size to a certain degree, it likewise becomes vacuolized (fig. 4, *D* & *E*, n').

Very remarkable is the occurrence within nucleus of a small lightly stained body shaped like a comma; it is found attached by its narrower end to the inner surface of nuclear membrane. It seems to be formed after the oocyte has advanced considerably in growth (see fig. 4, *D* & *E*, x). I know nothing to say about its nature or significance.

After the oocyte has grown to full size (0.2—0.3 *mm.* in diameter) and shortly before the ovulation by dehiscence of the follicular membrane, the nucleus begins to show changes preparatory to the formation of the first polar globule. The nuclear membrane is slackened, the linin network becomes indistinct and the nucleoli no longer exist as such; at the same time a number of chromatic granules make their appearance in the nucleus.

The oocyte after liberation from the ovary is spherical; it is supplied with a very thin vitelline membrane. Of the cytological changes which now take place in connection with the production of polar globules, the detail was given in my paper on the development of Actinotrocha (Jour. Sci. Col., Vol. XIII, 1900). Suffice it to say here that so long as the oocyte remains in the cœlomic cavity, the nuclear division figure is in the mesophase or in the metaphase. The chromosomes belonging to it consist, in *P. ijimai*, of six pieces; in *P. australis* there are twelve of them. The expulsion of the first polar globule takes place after the oocyte is expelled to the exterior through the nephridial funnels, at a time when it is met by the free-swimming spermatozoa. This is soon followed, without rest, by the formation of the second polar globule,—the well known reduction division, by which the chromosomes are reduced to half the normal number. Thus, in *P. ijimai* the fully mature ovum is in

possession of only three chromosomes of maternal origin. Exactly the same reduction occurs during the formation of spermatids, as will soon be pointed out.

The Testis and Its Products.—As to the development of the testis I have not been able to obtain as clear an insight as in the case of the ovary. However it may safely be said that the inceptional condition as well as the general manner of development are essentially the same. The small and flat peritoneal cells, remaining beneath the nutriment layer, proliferates, thus forming a crowded assemblage of small spermatogonia around a capillary at its basal portion. This is the first *Anlage* of the testicular tissue. As the spermatogonia increase in number, the overlying nutriment layer is lifted up by them; at the same time its cells become smaller and are evidently on the way of becoming totally resorbed, in much the same way as we have seen in the case of the ovary. Meanwhile, what is peculiar to the testis, the connective-tissue layer sends out fibrous bundles outwards and radially into the assemblage of spermatogonia, which soon arrange themselves around and along each of the said connective-tissue bundles. The spermatogonia thus form radial strings, the testicular strings, of which the connective-tissue bundle constitutes the axis. With the disappearance of the covering nutriment layer, the strings are somewhat loosened in their relation to one another and are seen to beset the capillary surface in a villi-like manner.

The above changes on a testicular capillary proceeds from the base distally towards the blind end. We may say that the testicular *Anlage*, consisting of a mass of spermatogonia traversed by radial fibrous bundles and covered over by the degenerating nutriment layer, shifts its position in the said directon, leaving behind it the testicular tissue just developed in the form of uncovered cellular strings and ever encroaching upon and lessening the domain of the nutriment layer in front of it. The advance of the growing end of the testicular tissue takes place in that the flat peritoneal cells remaining beneath the nutriment layer undergo proliferation *in situ* and thus give rise to new spermatogonia. The development of a testicular capillary is complete

when the entire vascular wall is covered by the loosend strings up to the blind end.

Pl. V., fig. 5 shows a cross-section of a fully developed and functional testicular capillary. (In the capillary lumen is seen a blood-corpuscle). It will be observed that the spermatogonia lining the testicular strings are very small in size and approximately spherical in shape. They contain a comparatively large and vesicular nucleus in which are visible a few number of dot-like chromatin. Towards the outer end of the strings they grow somewhat larger while the chromatin dots in the nucleus become more numerous and distinct. The largest cells at the outermost end may be called the spermatocytes. They are more or less detached from connection with the strings and are loosely adhering to one another in the periphery of the testicular capillary. Here the division of the spermatocytes into spermatids and the development of these into spermatozoa may without difficulty be studied.

In figs. 5 and 6, the same lettering has been used to denote the same stages in the spermatogenesis. The cell indicated by *a* is a loosely lying spermatocyte, in which the chromatin has the form of a spiral band (spireme). The cell *b* is another in a more advanced spireme stage. Soon the nuclear membrane dissolves away and the karyokinetic figure distinctly establishes itself. The rod-like chromosomes, in the equatorial plane of the spindle, number six in *P. ijimai* and twelve in *P. australis*. In *c* and *d* the karyokinesis is progressing; the division ensues, which is directly followed with another without the nucleus passing through a resting phase. The letter *e* indicates the daughter cell produced by the first division of a spermatocyte and *f*, one of the four spermatids given rise to by it after the second division. The spermatid is very small, corresponding in bulk to about one-fourth of the original spermatocyte. Only half the normal number the chromosomes enters into it, exactly as in a ripe ovum. Thus, in *P. ijimai* their number to each spermatid is three, which are at first so attached to one another with their ends as to present a triradiate figure (see fig. 5, *f*). This is soon followed by a stage in which the spermatid is supplied with

a small, spherical and compact-looking nucleus (fig. 6, *f*). In an early stage of the spermatogenesis we see that nucleus greatly condensed and transformed into a slender elongate shape, curved after the manner of the letter C (fig. 6, *g*). The bent nucleus is then seen to grow somewhat in thickness and greatly in length (*h* and *i*), eventually to stretch out as the head of the filiform spermatozoa (*j*), of which the tail is about twice as long as the head.

Explanation of Pl. V.

All figures relate to *Phoronis ijimai* Ik.

Fig. 1.—Cross section of a contractile capillary, externally covered over by a layer of large nutriment cells (" Fettgewebe ") derived from the peritoneal cells. *a, b*, large and small nutriment spheres. In the center are seen two blood corpuscles (*b.c.*), lying in the capillary lumen which is lined by the flat endothelium. (Zeiss, oc. 2 and imm. syst. $\frac{1}{12}$).

Fig. 2.—The efferent blood-vessel (*ef.*) in cross section and a piece of an ovarian capillary in longitudinal section. *c.l.*, capillary lumen, lined by endothelium. *f.p.*, flat and small peritoneal cells remaining at base of the nutriment cells. *fol.*, egg-follicles. *og.*, proliferating oogonia. (Zeiss, oc. 2 and imm. syst. $\frac{1}{12}$).

Fig. 3.—Cross-section of an ovarian capillary. Below and to the left, a small oocyte over which the nutriment layer is degenerating. Over the larger egg-follicles that layer has entirely disappeared. *l.c.*, capillary lumen. (Zeiss, oc. 2 and imm. syst. $\frac{1}{12}$).

Fig. 4.—Same. Centrally, three blood-corpuscles in the capillary lumen. A—E, oocytes in differet stages of growth. *n* and *n'*, two kinds of nucleolus. *x*, comma-like body of unknown character, attached to the inner surface of nuclear membrane. (Zeiss, oc. 4 and imm. syst. $\frac{1}{12}$).

Fig. 5.—Cross section of a functional testicular capillary. Centrally, a blood-corpuscle in the capillary lumen. Radially arranged spermatogonia-strings, each with an axis of a connective-tissue bundle. *a—b*, stages in the spermatogenesis corresponding to those denoted by the same letters in fig. 6. (Zeiss, oc. 6 and obj. 1.5 mm. apochrom. imm.).

Fig. 6.—Stages in the spermatogenesis. *a—b*, different phases of nuclear change in the spermatocyte. *c*, one of the two daughter cells formed by the first division of a spermatocyte ; the nuclear figure

in preparation for the second division. *f*, one of the four spermatids formed from a spermatocyte, with spherical nucleus. *g*, *h*, *i*, spermatids with dense, narrow and bent nucleus in different stages of growth into spermatozoan head. *j*, ripe spermatozoa. (Zeiss, oc. 12 and obj. 1.5 mm. apochr. syst.).

NOTICE.

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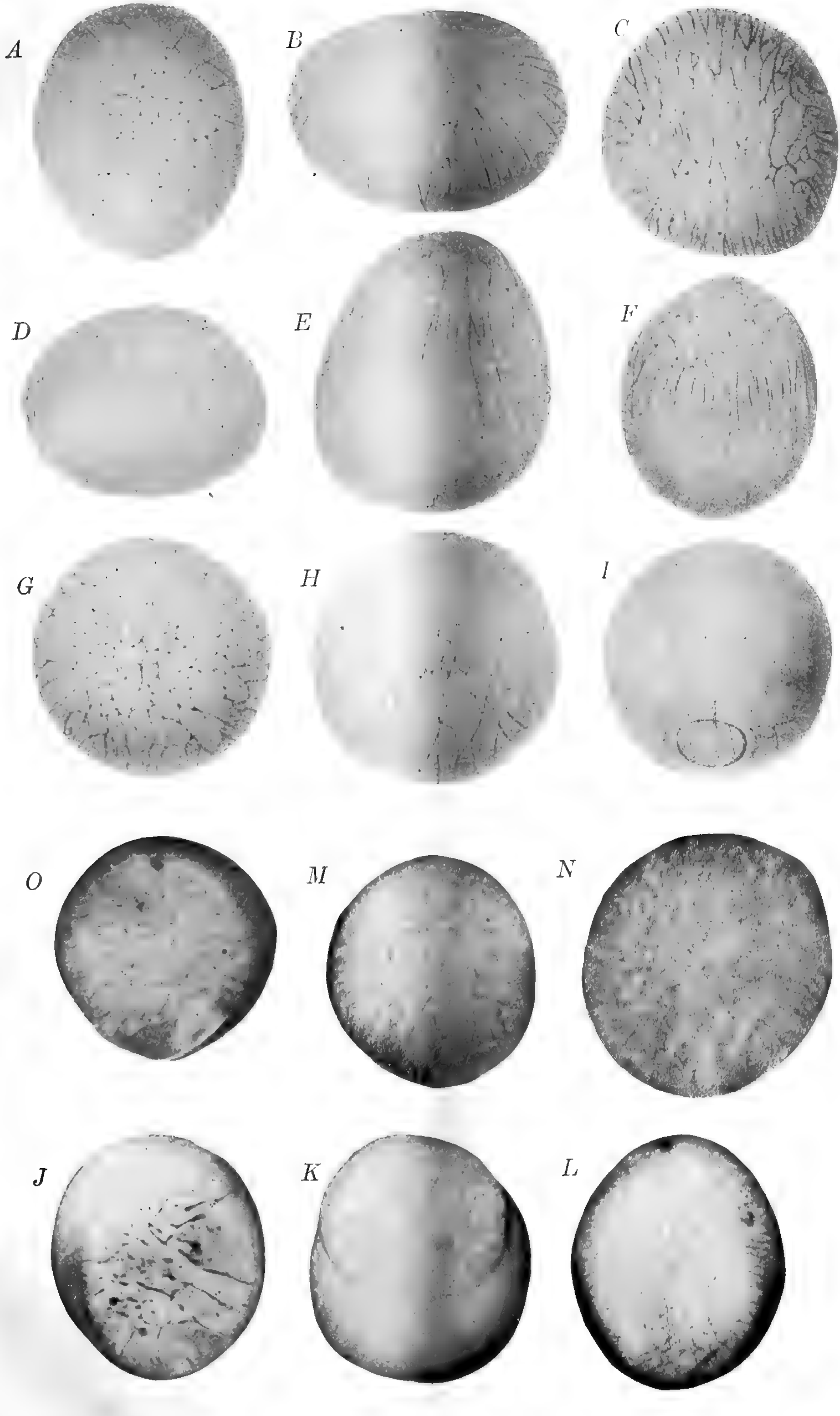
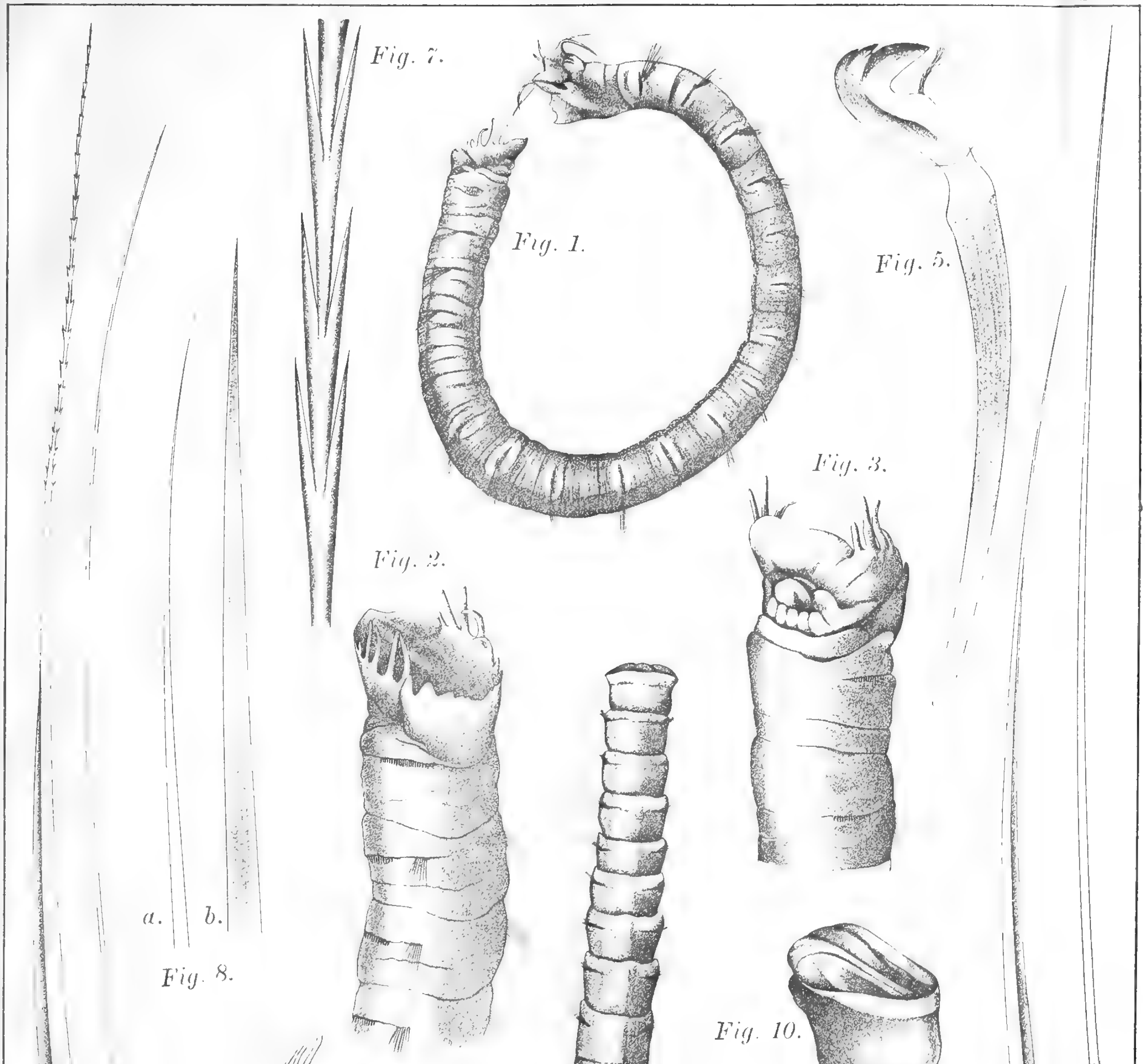


Artotype, by The Tokyo Printing Co.

Amphitretus pelagicus.

Natural size.



A. Izuka. del.

Two New Species of the Maldanidæ.

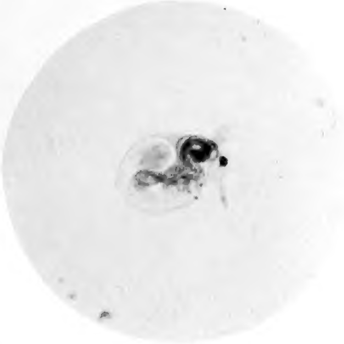


Fig. 1.

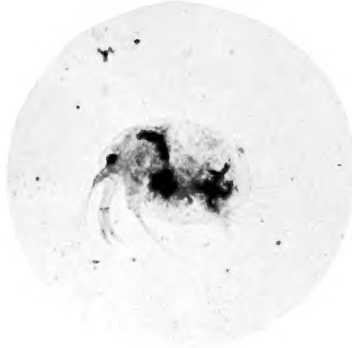


Fig. 2.

Fig. 3.

Fig. 4.

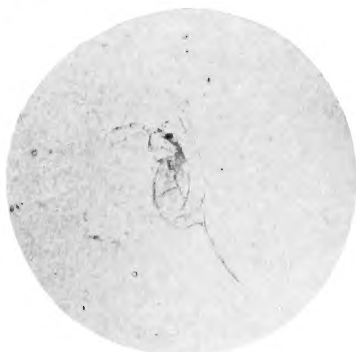


Fig. 5.

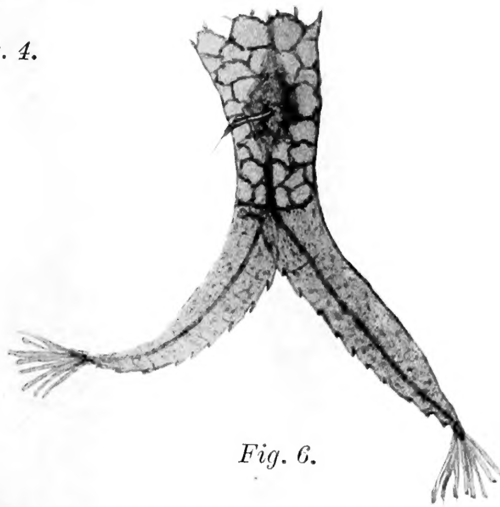
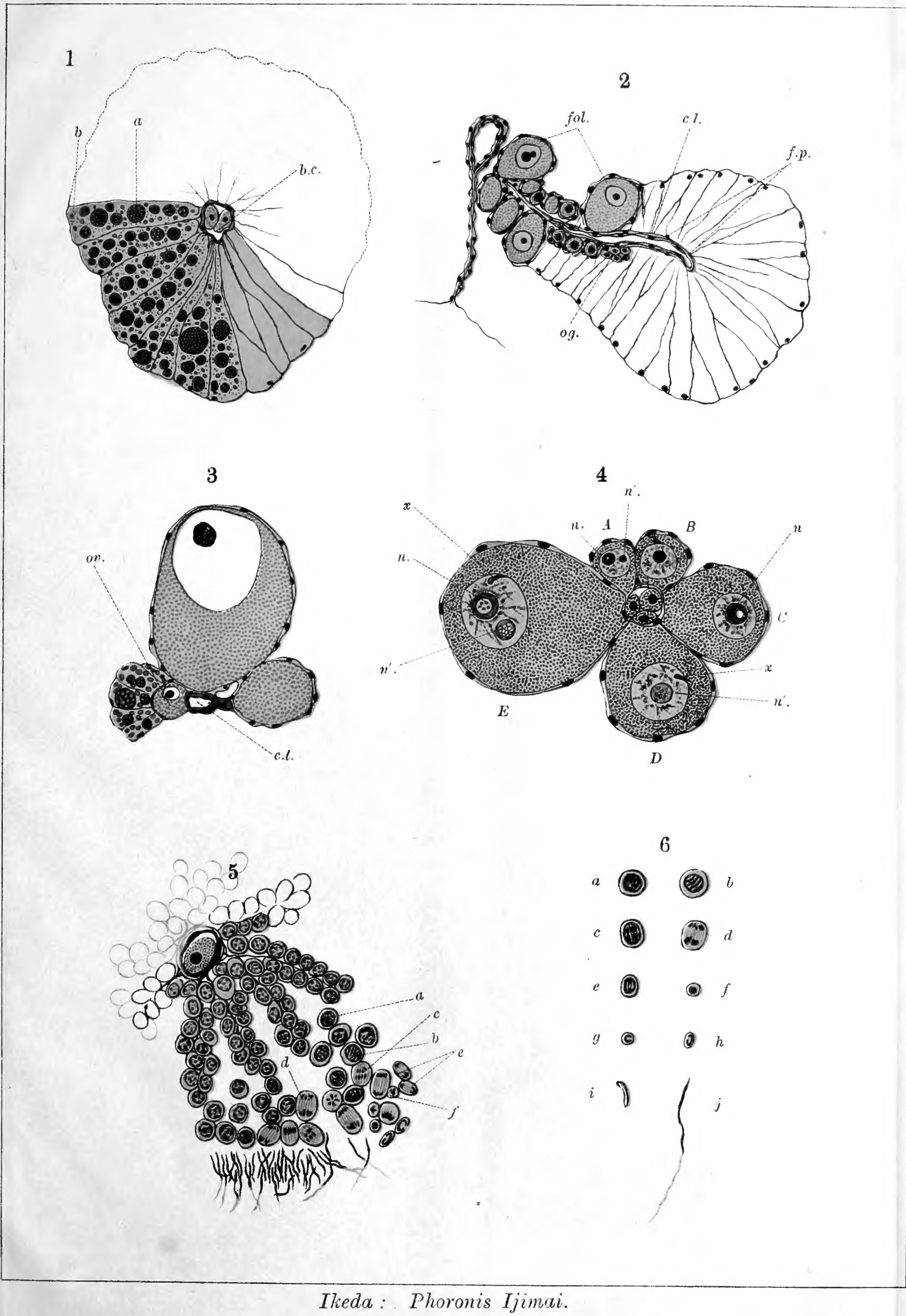


Fig. 6.

Bosminopsis.



Ikeda : *Phoronis Ijimai.*